Manual of
ENDOSCOPIC
URINARY TRACT STONE SURGERY

Including X-ray pictures, illustrations and keypoints.

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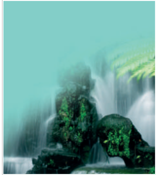

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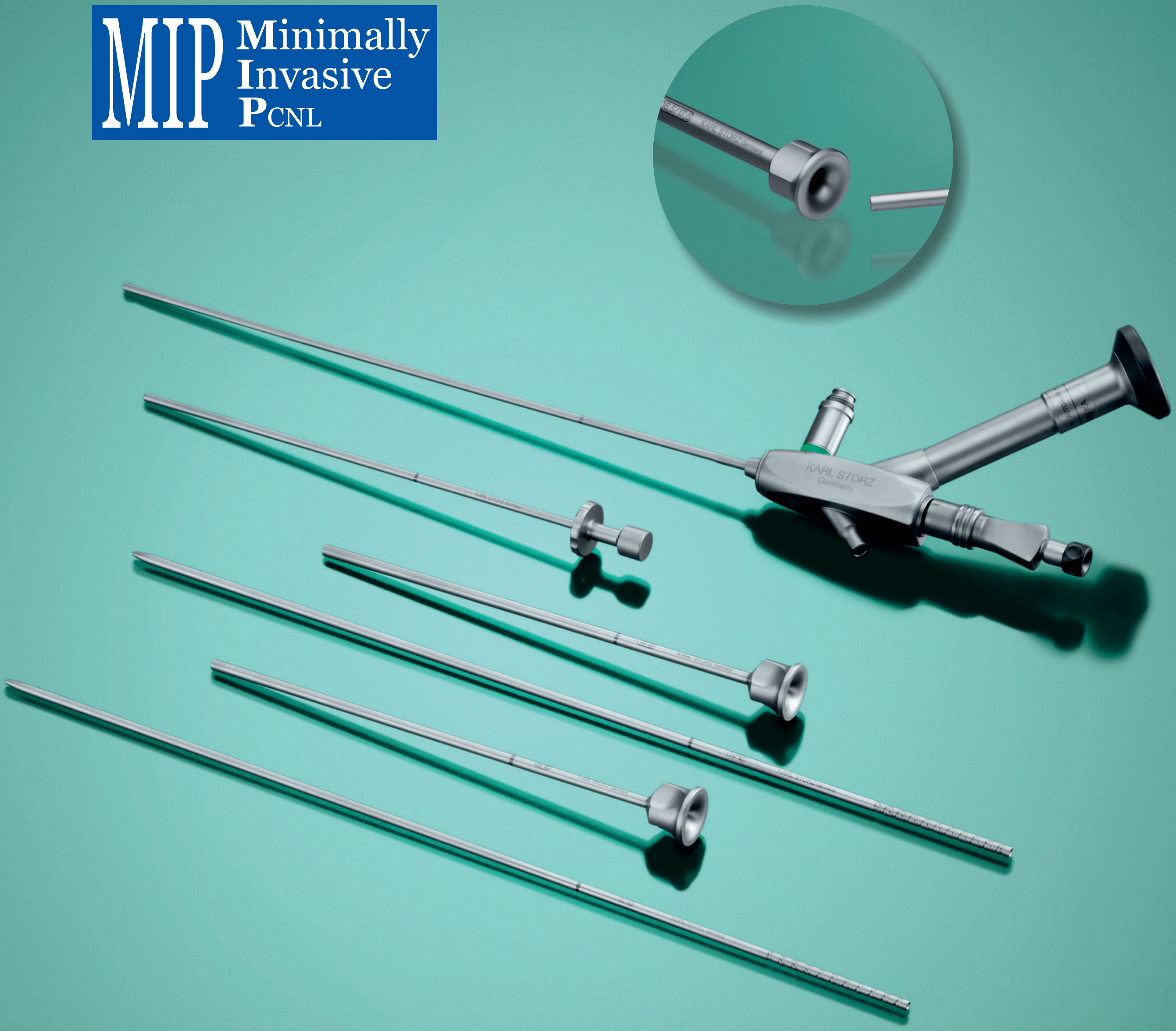

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Whom I cannot forget

This handbook is dedicated to three generous persons.

One of whom is my father ***Dr. A. Salam Khan*** *(late) who became the intercessor for me to come down to earth. He also provided me a platform to serve humanity through pioneering percutaneous surgery in our country and the region. The others are my kind teachers* ***Prof. Dr. Frigyes Kulka*** *(late) and* ***Prof. Dr. Csaba Tóth*** *who transferred their knowledge and skills which took me high to skies.*

Prof. Tóth, not only taught me but also extended practical help by visiting Sadikabad and sending his teams to establish a centre of excellence in a remote part of a developing country.

I owe everything to these great personalities.

Before commencing work on this edition and throughout the process of thoughts evolving into words my dear mother Safia Begum remained constant source of inspiration as she continuously reminded me for completing this book and my wife Fayeza Khan, in spite of her illness, facilitated me through every thick and thin in completing this project.

"A. Munim Khan"

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PREFACE

Almost 17 years passed by when the first edition of this handbook appeared. Though the customary hindrances in working in a developing country became the major factor in this delay, we gained quite a large experience in the meantime.

Previous and current edition are made possible with the courtesy of 'Karl Storz' of Germany as these are published by the support of Frau Sybill Storz-Reling. Mr. Jochen Cramer, Director 'Karl Storz' took special interest in publication of this book. Our aim is to proliferate knowledge in the underdeveloped regions of the world. I hope we maintain such tradition in future too.

Progress of technical development in endourology has a faster pace than its adaptation at places which lack resources and expertise. In this era of robotics if the fundamental techniques are learnt, it's easy to use more advanced equipment. Even by using basic equipment and with the essential learning many of the human urological diseases can be treated and stone is top on the list.

I am much indebted to Dr. Hugh N. Whitfield of King Edward VII's Hospital, London for his valuable suggestions when he went through the previous edition. I improved this edition in the light of those comments. Our effort of the previous edition was also honoured by appreciation extended by Prof. Guy Vallancien, Paris, Prof. Michael Marberger, Vienna, Dr. David Tolley, Edinburgh, Prof. Yoshihide Ogawa, Okinawa, Japan and Dr. Faissal A. M. Shaheen, Jeddah.

Where the pictures and diagrams have been replaced, narration has also been modified and some new procedures have been added which can be performed with the same equipment. Aim is to emphasize technique in simple language that may be helpful for a beginner contrary to text books those are research oriented. Sum up of the experience based on research is being presented in this handbook. This is another mere attempt towards service to humanity.

I thankfully extend my gratitude to Prof. Dr. R. John D'A Honey, University of Toronto who spared time from his busy schedule to go through the manuscript and wrote Foreword for this edition.

A. Munim Khan

FOREWORD

Since the early 1980s there have been numerous articles and a number of text books on endoscopic stone surgery. This little book is however unique in that it is a very practical book written by two urologist with an enormous personal experience. Each procedure is described clearly, with attention to detail, which allows the reader to use the book as a practical guide to each procedure.

The first edition was mainly aimed at practicing urologists in Pakistan, and developing countries where medical equipment is limited. This edition will clearly have a wider appeal.

There is an in-depth section on percutaneous removal of stones, starting with preparation of the patient and moving through patient positioning, anaesthesia, percutaneous access including planning and the technique, nephroscopy and stone disintegration. Possible complications of percutaneous surgery and their management is also covered. There is a section on endopyelotomy. There is also a section endoscopic removal of ureteral stones and an interesting section on their technique for percutaneous nephroscopic ureterolithotomy with a reference to their video on the technique. There are interesting sections on the endoscopic removal of bladder stones in both adults and children. Other topics covered include post-operative management of patients and stone prevention.

This excellent little book is easy to read with clear illustrations and photographs and I am confident that it will become a very useful handbook for many urologists.

R. John D'A Honey, MA MB B.Chir(Cantab) FRCS(Eng) FRCSC
Professor of Urology
Director of Endourology
University of Toronto. Canada

INTRODUCTION

(First Edition)

Medical science is progressively developing along with other rapidly developing fields. Daily new inventions and techniques are being introduced to minimize human suffering. While the cost of such treatment might be high by adapting new modalities and it may be beyond the reach of average patient in the developing world, yet the application of such technologies for treatment will, no doubt, benefit many patients.

Urinary Tract Stone disease in one of the commonest diseases in the area known as the stone belt around the world. Different factors may play a role in the stone formation which can be resolved to some extent. In a country like Pakistan, climate, poor hygienic conditions, unbalanced diet pattern and non-availability of clean water might play the major role along with other metabolic factors.

New modalities in the field of stone removal shifted from open surgery to percutaneous surgery and extracorporeal shock wave lithotripsy therapy completely in the advanced world. But this pace could not be maintained in the developing countries like Pakistan where either open surgery is being performed for urinary stones at most of the centres or ESWL therapy is used to crush stones at some centres. Unsuccessful ESWL therapy is replaced by open operations at all the places. It is an established fact that percutaneous surgery can be used as the best alternative to open surgery and it can be used also in combination with ESWL therapy where the stone is too large in size.

The advantages of percutaneous surgery are, very small incision, minimum operative and postoperative complications, short hospital stay, fast recovery after operation, and the patient can resume his daily life and start his work very soon which is an utmost requirement of today's life. In case of future intervention, the body and the viscera are free of adhesions. This book is a practical manual to perform percutaneous and endoscopic surgery of the urinary tract. We hope that the urologists in particular and medical doctors in general will take benefit from this book.

It starts with the historical review so that we should not forget those who spent their days and nights to develop the technique. This is the minimum tribute which we can pay to those dedicated scholars. Following chapters are the step wise details of different procedures which can be performed through endoscopic surgery. If followed properly, this book will serve as guideline for endoscopic surgery.

By the time this book was published new advancements have also appeared like the invention of pneumatic stone crushing, which will be mentioned in the next edition. But to follow the basic concept of endoscopic surgery, we hope our book will be really valuable and beneficial.

Our special thanks to Mr. S. Humayun Agha of Solaris Electromedical and Dr. Mazhar A. Zaidi of Millat Hospital for the contribution of their valuable time in editing the manuscript and publishing the book.

Authors

FOREWORD

(First Edition)

Endoscopic Surgery has been around for nearly 100 years. With the introduction of fibreoptics new possibilities were seen and quickly adapted. The phenomenal advances in technology brought new innovations and expanded the scope of urological interventions. Laparoscopic surgery has now also been introduced in urology.

The driving force behind these innovations was the rising cost of medical treatment linked with the desire to promote minimally invasive procedures. These procedures also reduced the time off from work and hence were attractive for the bread earners.

The innovations in equipment over the years have been remarkable. Today the scopes are smaller with bigger working port and sharper images. The pixel density has been increased despite using fibreoptics rather than rod lens. This has made the scopes more flexible without losing the image clarity. This, in particular, has made the ureteroscope rather easy to use.

The stone breaking equipment has also made stunning advances. The ultrasound and electrohydraulic systems have fundamental draw back. Both these systems cause ureteric damage although it is not serious in most cases. They are rather inefficient in breaking hard stones and have limitations in tackling large stones. The laser, despite its advantages, is too expensive. With the introduction of pneumatic system we are again back in business. This system does not damage the ureter, pelvis or bladder and is powerful thus reducing the operating time and we cannot manage large stones with confidence.

The introduction of percutaneous surgery for renal stones coincided with lithotripsy in early 80's. This somewhat dampened the fanfare in case of PCNL while ESWL took centre stage. Despite the rush for ESWL not all patients were being treated with this magic 'ray' machine. With time we also started to draw the lines and could better understand the limitations and complications of the new modality. The 80's was also a period where the profession was driven by the patients and finances. Now we are aware that ESWL is not a magic option for all stone patients.

The three months stone clearance rate of ESWL is about 40%. On the other hand, in America, the ESWL treatment cost over $34,000 as compared to PCNL which cost $15,000. For us in Pakistan both figures are excessive and the cost of stone surgery is quite low. No patient would choose an operation requiring general / local anaesthesia and a cut, whatever the stone size, in place of 'operation with rays'. Urology is the first specialty where a 21st century procedure has been introduced today.

Nevertheless, old technology does not disappear and with new innovations it again becomes relevant.Today ESWL has not replaced PCNL but both complement each other.

The cost of equipment and treatment is of vital importance for a country like Pakistan. The initial cost of ESWL is still prohibitive for us. PCNL has an important place in Pakistan. This has been shown by Dr. Munim Khan. Working in a small town in southern Punjab he has used PCNL and other endoscopic procedures for the benefit of the patients in his area. Sitting in the stone belt of Pakistan he has no dearth of patients and has accumulated a vast experience in endoscopic stone surgery, which is reflected in this book, co-authorised with Professor Tóth from Hungary.

This monograph is well documented account of endoscopic procedures in urology and will prove useful for the young urologist. Following the lead of the British, most medical books produced in Pakistan target the students appearing in their examination. It is refreshing to see a book describing procedure. We need more of such publications. However, learning skills is by actually doing it. Endoscopy is not different. I wish a chapter on the care of equipment was also included. This is a weak area of Pakistan. Nevertheless, this monograph will boost the neglected, though an important urologic procedure, in Pakistan.

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HISTORICAL REVIEW

1

"Lest we forget our predecessors, we walk on their footprints.
They struggled to ease human beings of their suffering by
inventing new tools for diagnosis and treatment"

PART ONE

URINARY TRACT STONE DISEASE

Urinary tract stone disease might be existing since the beginning of mankind. The first evidence of renal stone seen was found by Sir Marc Armand Ruffer in the excavations of prehistoric Egypt[1] in a mummy belonging to 1st Egyptian dynasty. G. Elliot Smith[2] writes that the first Egyptian body that he ever saw in situ was a prehistoric youth with a vesical calculus.

Removal of stone would have been the next step after discovering its presence in the urinary system. Though primitive ways of treatment had been applied among the medical professionals of different civilizations in different periods, it is rare to find complete method of operations in writing from the earlier periods.

History starts with removal of stones in the urinary bladder. Documented cases of kidney stone removal are seen much later. It might be due to lack of diagnosis of renal stones or knowledge of internal anatomy due to social apprehensions or some other factors.

URINARY BLADDER STONE REMOVAL:

In the ancient times we find the first exact description of lithotomy from Roman era. Nearly all the historians are of the opinion that it was Celsus (? 50 BC) who described perineal lithotomy precisely in the seventh volume of his 'De Medicina'[3]. Different surgeons of different times improved the same technique till the beginning of 18th century. But the commonality among different continents and civilizations was the role of wandring lithologists going from city to city and village to village taking their 'operation theatre' (Fig. 1) with them.

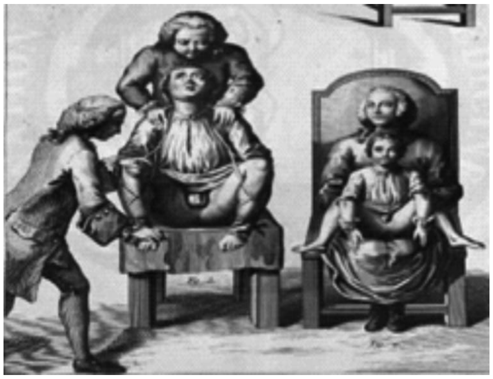


Fig. 1. The table and chair to be used for performing lithotomy and lithotomy position of the patient. Note that hands and legs of the patient are tied up with straps. (Tolet F: Trait de la lithotomie, 4th edition, Paris, 1689)

In 1150 AD, Gerard of Cremona translated 'Al- Tasreef'

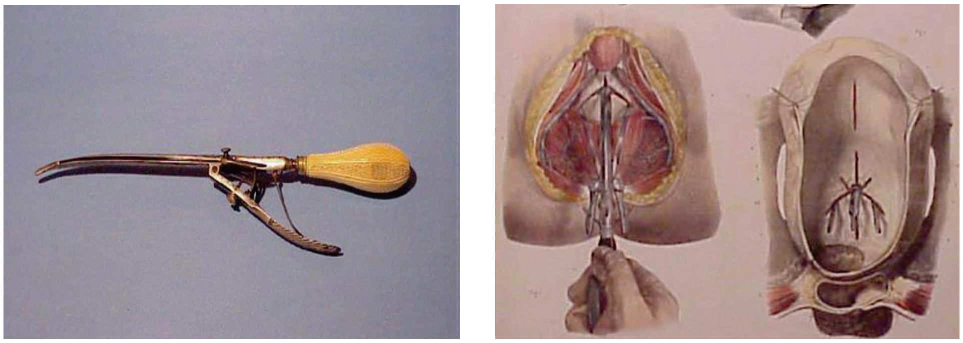


Fig. 2 Frére Jacques Beaulieu's instrument and method of its application

by Albucasis (930 – 1013 AD) into Latin and it became a reference book in Europe till 18th century[4]. It clearly showed improvement in technique of operation and reduced risk factors as compared to other civilization. During Renaissance period in Europe most of the well-known lithotomists such as the Italian 'Marianus Sanctus' (16th century AD), the French 'Frére Jacques Beaulieu' (17th century AD) and the English 'Cheselden' (18th Century AD) who modified Beaulieu's technique (Fig. 2) were using Albucasis's the left lateral incision[5]. Frére Jacques Beaulieu, a traveling clergyman, was so popular in France that according to some historians nursery rhyme "Frére Jacques, Frére Jacques, dormez vous, dormez vous? Ö." was written in his tribute.

The actual person who advocated suprapubic approach for urinary bladder stones was Rousset of France believing that suprapubic route was far more practical than perineal approach for vesical calculi[6], but it did not much prevail in the next two centuries and perineal approach was practiced by most of the surgeons. In 1718 James Douglas presented a paper in England mentioning the advantages of suprapubic approach. Cheselden who was surgeon of St. Thomas Hospital took up the idea and others followed. In such a way the idea of Douglas spread in England and onto the continent[7].

While switching over from perineal approach to suprapubic one[8], commencement of 19th century brought with it the start of perurethral lithotrity for urinary bladder stone removal.

HISTORY OF STONE FRAGMENTATION:

We find slow progress of development of endosurgical instruments till 16th century. 17th and 18th century observed comparatively enthusiastic changes in the instrument development.

Stone fragmentation can be divided into two phases. One is the era that consists of development of instruments to break bladder stone without looking into bladder. The other is the period in which under vision stone breaking instruments developed into present form.

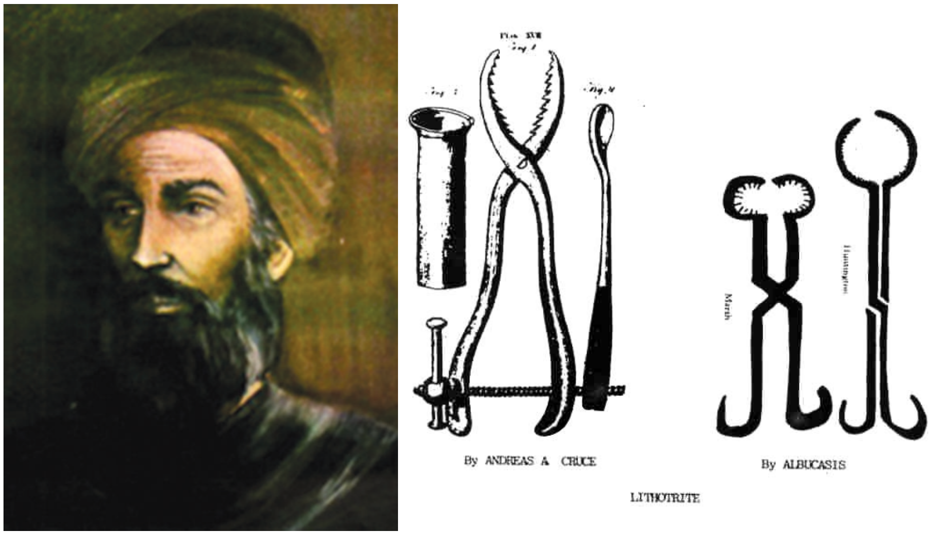


Fig. 3 Albucasis and his lithotrites (Spink & Lewis, 1973)

Development of Instruments – Stone removal without observing inside (Blind approah)

The lithotomists till the 4th century AD warned against any attempt to fragment stone before its extraction[9]. Albucasis was first to describe an instrument and the stone crushing technique inside the bladder and its piecemeal removal. Approach was through left lateral periurethral incision. Spink and Lewis [10] and Kirkup[11] consider his innovation to crush and remove the stone as the foundation of lithotripsy principle (Fig. 3).

It had long been a wish of the surgeons to create instruments which work inside the body through natural route. 19th century brought with it rapid changes and modification in the instruments (Fig. 4). Then started the era of perurethral stone crushing inside the urinary bladder (lithotrity) and Civiale's instrument is a good example of such endeavour. He developed many lithotrites and the one

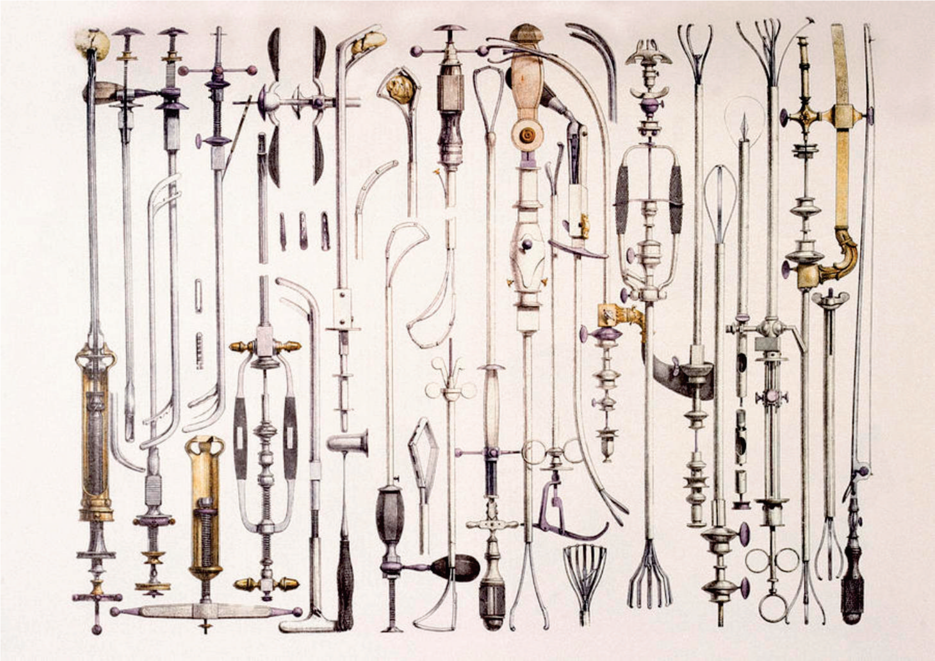


Fig. 4 Bourgery's illustration of some of the instruments that were used for stone removal in the first part of the 19th century

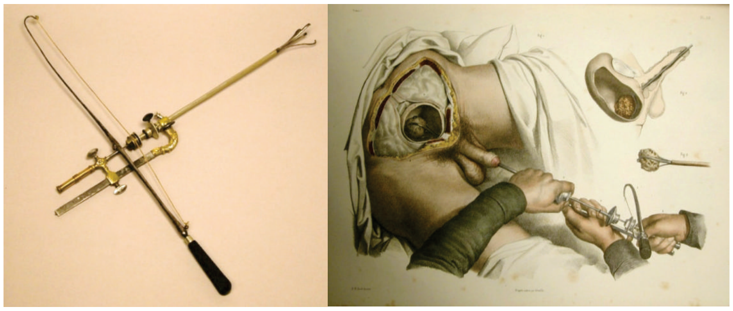


Fig. 5 Civiale's Lithontripteur and its utilization

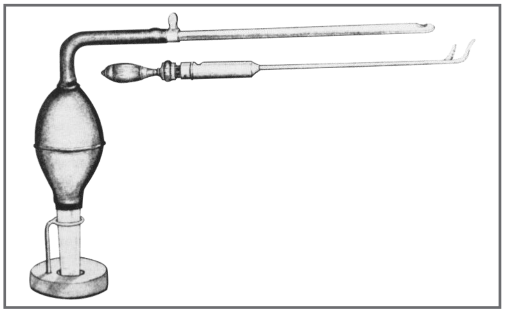


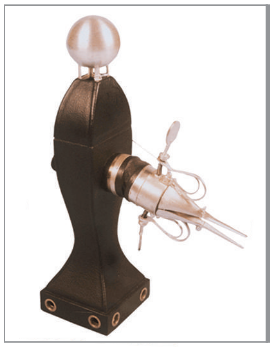
Fig. 6 Bigelow's lithotrite for crushing the stone and fragment collecting instrument

shown in the picture (Fig. 5) was the best of his attempts.

Civiale devised his first instrument in 1824 which he modified with the passage of time. He was strongly opposed by his contemporary surgeons but Shelley[12] writes him as true pioneer who provided sound base to the procedure.

The instrument for breaking stone evolved to present lithotrite. In this journey it was given different names, Lithoprine (Le Roy), Lithontripteur (Civiale) and Pierce-Pierre (Heurteloup) [13].

When the stone is crushed inside, how to remove the fragments? Henry J. Bigelow in the United States presented its solution by introducing his instruments for stone crushing and washing in 1870's. Picture of his instrument is given in (Fig. 6).



This is the instrument of Bozzini.

He was backed by The Kaiser of Germany but was opposed by the physicians of that time

Fig. 7 'Lichtleiter' of Bozzini

Now we find more advanced forms of stone breaking in shape of ultrasonic, electrohydraulic, pneumatic and laser lithotripsy that are routinely used in endourology but accompanied by different scopes to view inside.

Development of Instruments – Inside observation

When we trace history for the people who took active part in instrument development for viewing inside the body, Phillipp Bozzini's name is the first one who invented 'lichtleiter' in 1806 using candle light and lens system to view the bladder through female urethra[14] (Fig. 7).

Désormeaux (1853) in France and Nitze (Berlin) & Leiter (Vienna) (1867) used lens system in their scopes to view inside the urinary bladder.

In 1883 Newman (Glascow) used light bulb at the end of cystoscope and observed inside the bladder.

Hopkin and Kopany (1952) brought revolution in the world of endoscopy by using fibreoptics for transmission of light from external source.

Modern developments in endoscope evolution depends upon the same principles mentioned above with better light transmission, wider and clear view inside.

An advanced era starts in the beginning of 20th century when Hugh H. Young introduced the first-ever lithotriptoscope. By using Bigelow's apparatus as a model, in 1908, he introduced a modification in which the stone could be viewed during holding and its crushing. Dr. Young (1870-1945) is universally acknowledged as the father of modern urology. He was the pioneer member of American Urological Association and the founder of Journal of Urology.

Now we have well developed scopes furnished by lens system to view inside and fibreoptics are used to transmit light to inner cavity

KIDNEY STONE REMOVAL:

Mathé[15] tracks scientific background of renal surgery to Hippocrates, who never performed renal surgery by himself but mentioned different operations like drainage of abscesses and incision of swelling in the loin due to obstructed kidney and stone. He also wrote about an Arab physician Serapion from Damascus who by the end of 10th and beginning of 11th century advised removal of kidney stone through lumbar incision. In Wolfangus Justus's words '*Quidam antiquorium praeceperunt lapidem renium extrahi cum ferro incidente, retro uper latus duroium iliorum in loco renum*' (Someone among ancients has prescribed to extract kidney stone from behind by means of cutting iron penetrating through the back at the level of the region of the ilium) [15].

Almost all historical manuscripts refer to the supposed first recorded case[16] of stone removal from franc-archer of Bagnolet's kidney. He was a criminal and was awarded death sentence by French court.

Talking about first accurately recorded *nephrolithotomy* case, it was done in February 1880 by Henry Morris[17]. He successfully removed a 31 gram stone from a healthy kidney. He described the detail of that operation in his Huntarian Lecture for 1898. William Ingalls was also the pioneer of nephrolithotomy in the United States who operated a large renal calculus at Boston City Hospital by lumbar approach. Though he did it in 1872 but he could report the case only in 1882 thus the others took the credit of nephrolithotomy[18].

Diagnosis of Stone in the Kidney

In earlier period, nephrolithotomy was performed when beside other symptoms the flank was swollen or abscess formed. It was operated upon and stones were removed. A strange method for confirmatory diagnosis of kidney stones was mentioned by Seymour[19] in 1884 and Tiffany[20] in 1885 who declared that they took the help of long needles to search the exact location of stones in a kidney.

Then there came a turning point. German physicist Wilhelm Conrad Röentgen discovered X-rays in 1895 and submitted his preliminary report "Uber eine neue Art von Strahlen" to the president of the Wurzburg Physical-Medical Society, accompanied by experimental radiographs and the image of his wife's hand (Fig. 8).

Later on that discovery served as vital diagnostic tool in medical profession. It also gave a boost to

Fig. 8 Wilhelm Conrad Röentgen (1845-1923) and his first ever human skeleton picture

renal surgery and it became easy to locate radio-opaque stones. McIntire[21] in 1896 demonstrated positive films for stones in five cases with renal calculi.

The next step was to render the urinary tract opaque and to define radiolucent stones. Initial trials were the retrograde ones. The first reported case was by Tuffier in 1897 in France, who used an opaque catheter to determine the position of renal pelvis and outline the ureter. Then the era of pyelography started in urology. Volker and Lichtenberg in 1906 [22] and Keyes in 1909 used different contrast materials to outline urinary system. Intravenous urography was also the advent of the period between 1920 and 1930.

Now X-ray image intensifier is an integral part of operation theatre to perform endoscopic urinary tract stone surgery.

PART TWO

PERCUTANEOUS STONE REMOVAL

Development of percutaneous stone removal comprises of three phases. For the first time residual stones were taken out with the help of a forceps after the removal of nephrostomy drain which was put in an early operation for kidney stones. Later radiologists worked out such a technique in which kidney was punctured, the channel was dilated and the stone was removed under X-ray control. The last phase of development was the invention of methods which were not mechanical (ultrasound, electrohydraulic, pneumatic and lasers) for disintegration of stones and the nephroscopes were especially made for that purpose. These methods still exist.

In the beginning percutaneous stone removal was thought to be the method for only residual stone removal in already operated cases. In 1981 Wickham stated that percutaneous method is the method of choice even in the primary stone cases. In English and German literature ten well documented cases can be found between 1941 and 1980 in which renal stones were removed endoscopically with good results. In all these cases nephrostoma was made in a previous open operation. After 1980 this method for kidney stone removal rapidly developed and today it became the integral part for the solution of kidney stone problems.

A chronicle of percutaneous stone removal[23]

1941: Rupel and Brown introduced panendoscope through the nephrostomy catheter inserted in a previously operated case of left solitary kidney and the obstructing stones were removed with the help of forceps. This procedure was done under narcosis.

1955: Goodwin, Williams and Casey inserted puncture needle in 18 cases with hydronephrosis under local anaesthesia and X-ray control. Through it a rubber tube was inserted into the renal cavity.

1970: Lutzeyer et al, in vitro, performed renal calculus disintegration ultrasonically.

1971: Gasteyer used ultrasound for urinary bladder stone disintegration.

1974: Bissada, Meacham and Redman removed two impacted stones from the left kidney draining into the ileal loop. They did it with the help of panendoscope and resectoscope. It was performed after dilating nephrostomy channel prepared at an early operation.

Brantley and Shirley removed residual stones in two cases with the help of U-shaped nephrostomy drain, panendoscope and stone basket.

1975: Harris was the first one to use flexible fibreglass optical bronchoscope to remove residual stone from the kidney after an open operation. This procedure was performed through the nephrostomy channel.

1976: Fernström and Johansson reported three cases with kidney stones. Percutaneous nephrostoma was made and gradually dilated through days with Couvelaire catheters. Stones were taken out through the catheter under X-ray control with the help of Dormia basket and stone grasping forceps.

Rathert disintegrated stones ultrasonically in a functionless kidney.

Weiss pushed down the stones from kidney to ureter with percutaneously applied hydraulic impulses. Impacted stones were removed through catheter.

1977: Goodman performed ureteroscopy with child cystoscope. Günther punctured kidney with fine multichannel needle causing minimum injury to the kidney thus overcoming the difficulties in antegrade pyelography and percutaneous nephropyelostomy.

Karamcheti removed stone from pelvis with Randell`s forceps through the track of a drain after its removal. That drain stayed inside the patient for two years. Kurth broke a staghorn stone into pieces ultrasonically. He dilated the channel of an elliptical nephrostomy drain which was inserted five years ago. Through the dilated channel he introduced a cystoscope and ultrasound probe into the renal pelvis.

1978: Lyon & co-workers[24] performed transurethral ureterostomy and removed ureteric tumour with child resectoscope. Smith and his companions used combined retrograde and antegrade approach to remove ureteric stones.

1979: Dretler & co-workers performed litholysis through percutaneous nephrostoma. Sadlowski and his fellows performed ultrasonically guided renal puncture.

1980: Perez-Castro and Martinez-Pineiro[2] reported that whole ureter from the ureteric orifice to the renal pelvis can be examined completely and reliably with ureterorenoscope or ureteropyeloscope. The instrument used was invented by them and it was well effective.

Thüroff and Hutschenreiter performed renal puncture under local anaesthesia and the stone was removed with the help of cystoscope and Zeiss loop.

1981: Alken & co-workers reported 34 renal stone patients. Elective nephrostomy was performed in 19 patients. In 13 patients stones could be broken ultrasonically and removed. In these cases percutaneous channel was dilated till 26F in one week and renal stone was disintegrated with an instrument which was originally made for endoscopic manipulation of the urinary bladder. Special metal telescope bougies were made for dilation of tract.

Gerber, Brown and Culp dilated percutaneous channel immediately after puncture till 16F and a catheter of the same size was placed in the kidney.

Marberger, Stackl and Hruby[25] introduced a nephroscope into the kidney, dilated the nephrostomy channel for 2-6 days and disintegrated the stone with ultrasound.

Wickham and Kellett performed elective percutaneous nephrolithotomy in 31 cases and emphasized that such procedure can be also be applied to those patients who already have not been operated for kidney stones.

1982: Alken et al, removed renal stones percutaneously from a larger group of 63 patients and mentioned their experience, observations and complications.

1983: Clayman and co-workers performed electrohydraulic disintegration of staghorn stone through nephrostomy channel. Local anaesthesia was used and postoperatively renal cavity was irrigated with hemiacidrin solution.

Goodfriend performed ultrasonic disintegration of ureteric stones for the first time.

Huffman and co-workers mentioned about their first experience of disintegrating renal calculus ultrasonically through ureteroscope.

Korth started percutaneous stone removal with a new type of pyeloscope with continuous irrigation.

Since 1984 technical developments and modifications including staghorn stone extraction[26,27] are in progress in the field of percutaneous stone removal.

Percutaneous endoscopic renal stone surgery in Hungary

1927: Noszkay reported at the meeting of Hungarian Urological Society that he performed pneumopyelography percutaneously.

1979: Porkolab and Mohacsi used percutaneous renal puncture to search for the causes of renal cavity dilation of different origins.

1981: Frang and co-workers took out an already inserted renal drain and removed two residual stones with the help of a forceps through its channel using X-ray image intensifier.

1982: Simon and Szüle reported about the role of percutaneous kidney puncture.

1983: Pajor and co-workers resolved septic pyelitis during pregnancy with percutaneous nephrostomy.

1984: Csaba Tóth and co-workers performed elective endoscopic primary percutaneous nephrolithotomy for the first time in Hungary.

Hamvas and co-workers wrote about their experience of the renal cavity puncture.

1985: Csaba Tóth and co-workers used ultrasonic lithotripter in cases of endoscopic primary percutaneous nephrolithotomy. Same method was used for the removal of staghorn stones. Nephroscope and ultrasonic lithotripter was used for urinary bladder and urethral stones. They also introduced ureterorenoscopy and ureterolithotripsy in the country.

Rozsdy used self-made instruments for percutaneous stone extraction.

1990: Endoscopic stone extraction gained ground in the country. About 35 institutes are working with the necessary instruments to remove the stones.

1991: Csaba Tóth & co-workers[28] reported 600 cases of percutaneous monotherapy of staghorn stones in the kidney.

1992: Endre Holman & co-workers[29] presented the 1st case of laproscopically controlled stone removal from a pelvic dystopic kidney.

1997: A. Munim Khan & co-workers[30] reported the combined results of 320 endopyelotomy cases. Those cases were done in Hungary as well as in Pakistan.

Percutaneous Renal Stone Surgery in Pakistan

1993: Percutaneous surgery was introduced as complete therapy with the guidance of Hungarian school in Sadikabad, pioneering the technique in Pakistan and Mid-Eastern region. Initial results were presented in the 1st International Symposium of SIUT in 1994.

1996: Instruments for PCNL were used for percutaneous surgery in paediatric patients with bladder stones and the experience was presented for the first time at World Congress of Endourology at Melbourne, Australia[31].

1997: Percutaneous nephrolithotomy was performed in a patient in later period of pregnancy and the experience was published in the Journal of Rawalpindi Medical College[32].

1998: Author's study of Simultaneous Bilateral PCNL in 23 patients[33] (Paediatric as well as adults) was published in Pakistan Journal of Medical Research

2002: Bilateral Percutaneous Nephrolithotomy experience was shared in British Journal of Urology by the author[34].

2005: Bilateral paediatric PCNL experience share in BJU International by the author.

2008: Rana AM and co-workers[35] shared their experience of PCNL in supine position and tubeless PCNL.

2013: Percutaneous renal surgery is gaining ground in the country. It is being used at therapeutic level in more than 15 institutes of the country.

Pace of Endourological technique adaptation is slow in developing countries due to lack of costly equipment, training and deficient clear demarcation of different specialties.

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THE PATIENT

2

Patient is selected for percutaneous stone removal at the time of hospital admission. Most of the patients appearing have an already diagnosed stone in the kidney. A few patients show up with the complaints of dull backache and on examination a staghorn stone is found. There are some cases who never had a complaint, sudden colic led them to hospital and on examination both kidneys were found to be full of stones. Rarely patient has bilateral 'silent' stones discovered incidentally. The cause of acute renal colic in large majority is impaction of smaller size stone at the ureteropelvic junction or its migration into the ureter and causing back pressure. In case of impacted stone, its immediate removal and decompression of kidney is advised to overcome non-alleviating sharp pain before it causes irreversible renal damage.

Ratio of calculus renal failure is quite high among the inhabitants of under-developed areas as compared to urban population due to illiteracy and different other factors.

While perirenal scar adhesions create difficulties in an open reoperation, these postoperative adhesions rather help fixating kidney during percutaneous intervention and the manipulation is easier. On the other hand a recurrent stone in lower calyceal system of such patients may be difficult to be removed due to channel making through tough scar.

Mobile kidney may slip away from the puncture needle but this difficulty can be overcome with some skill and efficiency. Mostly the young children and slim patients have excessive renal mobility. Generally all the patients can be operated percutaneously if there is no distinct contraindicating factor.

Gibbous and kyphoscoliosis[1, 2] do not cause hindrance in percutaneous nephrolithotomy. Percutaneous surgery is better option than open surgery in such kidney stone patients. We met such cases in our practice and removed stones successfully percutaneously (Fig. 9, 10). Such patients faced torturing pain for years. Open operation could not be performed due to difficulty in positioning the patient on the operation table. On the side of the kidney with stones ribs slipped over the pelvic rim and the vertebral column could not be bent laterally and traditional open operation could not be performed.

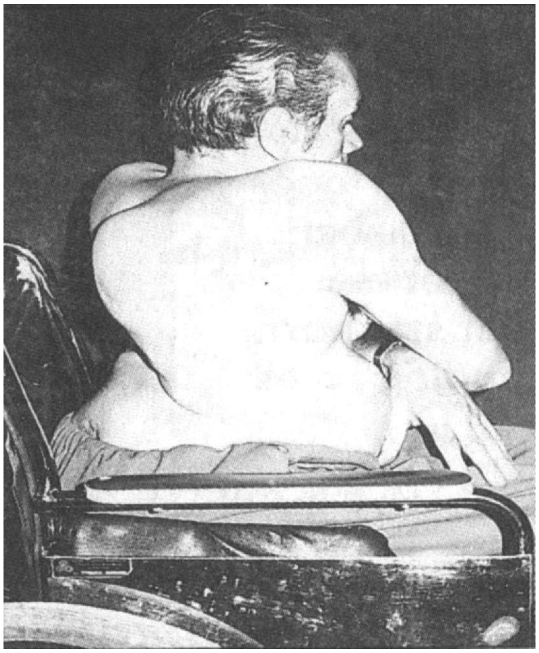

Fig. 9 Kyphoscoliotic patient

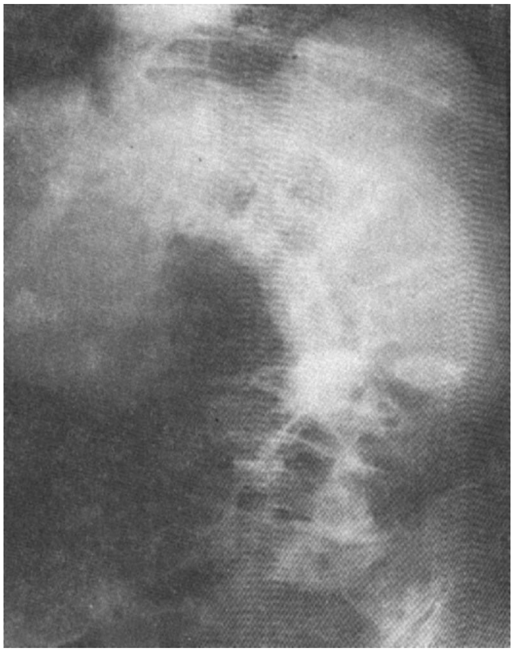

Fig. 10 Stone in the left kidney

Obesity or some physical deformity can cause difficulties in positioning the patient on the operation table. Sponge cushions of different sizes can be used to position the patient optimally for operation. In extreme obesity or pregnant stone patients[3, 4] (Fig. 11, 12) no cushion was used and the patient was placed in semi-oblique prone position.

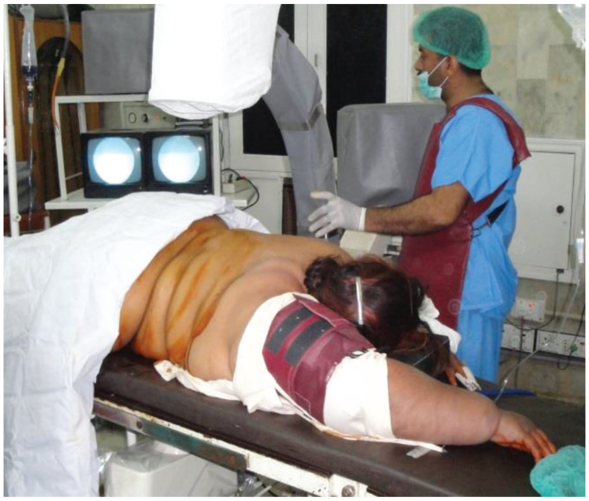

Fig. 11 Position in obese patient

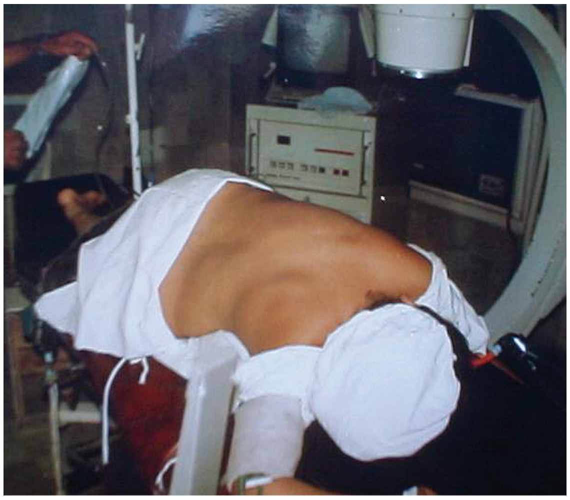

Fig. 12 Position in 32 weeks pregnant lady. Same position is applied to respiratory distress patients.

Indications

The indications for percutaneous kidney stone removal are the same as those of open operation. Stone may be in the kidney, upper or sometimes middle third of ureter. All the patients can be operated by this method if there is no contraindication. List of relative contraindications is given below:

- Too weak patient with unfavourable general condition.
- Bleeding disorders like haemophilia.
- Decompensated cardio-respiratory condition, diabetes mellitus, hepatitis, cirrhosis liver.
- Symptomless non-obstructing "silent" stones.
- Stones which can pass spontaneously.
- Symptomless bilateral staghorn stones while the patient is hypertonic, diabetic, arteriosclerotic and extremely obese.
- Extremely large and irregular staghorn stones with branches extending to all the calyces[5, 6, 7] (Fig. 13).
- Multiple stones of different sizes scattered in all the calyces (Fig. 14).

The last three types of patients can be operated percutaneously in multiple sessions provided the kidney is functioning. Otherwise, in all the contraindicated cases, first the medical specialist and anaesthesiologist renders the patient fit for operation.

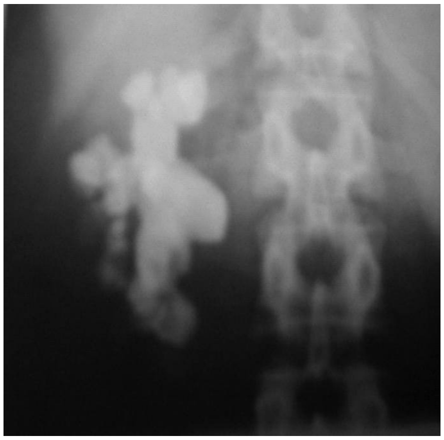

Fig. 13 Staghorn stone occupying whole cavity

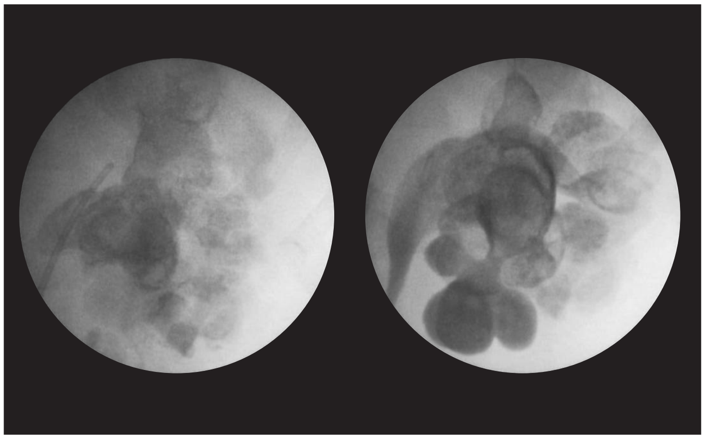

Fig. 14 Multiple complex stones scattered in kidney

Examination of the patient

The patient is examined for percutaneous nephrolithotomy as if he is prepared for open operation. History and physical examination are important along with ultrasound, X-ray and laboratory tests.

Plain X-ray and intravenous urography is required to estimate the kidney functions. These are also helpful in determining the shape, site, position, size, and number of stones and their relation to the renal cavity. Urinary flow obstruction is also noted. Immediately before operation plain X-ray is taken to observe the latest position of the stone.

Urinary sediments and bacterial culture is important before as well as after the operation to administer exact antibiotic to the patient. Its purpose is not only to disinfect the urinary tract but also prevention of recurrence particularly in cases of infection stones.

Viscosity of urine, proteins, sugar and urobilinogen levels are also determined.

Blood creatinine, urea, uric acid, electrolytes (Na, K, Ca, Mg, Cl), proteins and sugar levels should be estimated. Haemoglobin level, ESR, TLC, bleeding and clotting time, prothrombin level and qualitative blood tests should also be performed. Liver function tests (bilirubin, SGOT, SGPT) along with HBsAg (hepatitis B) and HCV (hepatitis C) are also important because of their endemic nature in under- developed countries.

Most of the patients with moderate stone bulk can be operated under local anaesthesia but the opinion of medical specialist and anaesthesiologist is taken in all the cases. Anaesthesiologist support is required in all the cases during operation.

Key points

- Anaesthesia or critical care requirement is the same as for open surgery cases
- Operation preliminary requirements are the same as for open operations
- Spectrum of operable stone cases is wider than open surgery
- Almost all the stone patients can be operated through percutaneous surgery
- Multiple sessions can be applied to risky patients and patients with huge bulk of stone

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THE KIDNEY

3

Adult kidney is 10-12 cm long, 5-6 cm wide and 2.5-4 cm thick. Left kidney is somewhat larger and higher than the right kidney generally. Its significance appears when the percutaneous channel is made through 12th or higher intercostal space because the risk of pleural injury increases on the left side.

At rest, 12th rib overlies the kidneys. On respiration and body movements the kidneys move up and down.

Renal cavity can be classified into three types generally.

Dentritic type:	Minor calyces open into major calyces and 2-3 major calyces into the pelvis.
Ampullary type:	Minor calyces open directly into the pelvis.
Transitional type:	Some minor calyces open directly into the pelvis while the others open into the major calyces which in turn drain into the pelvis.

Total number of papillae is 8 - 18. 1 - 3 papillae open in one minor calyx. Classic order of kidney has 14 lobes and 8 - 13 minor calyces which in a typical case, are arranged in a posterior and anterior line. On the anteroposterior view of urographic film posterior calyces line up medially while the anterior ones lie laterally (Fig. 15). The order of calyces has significance while locating the stones and to puncture the kidney successfully.

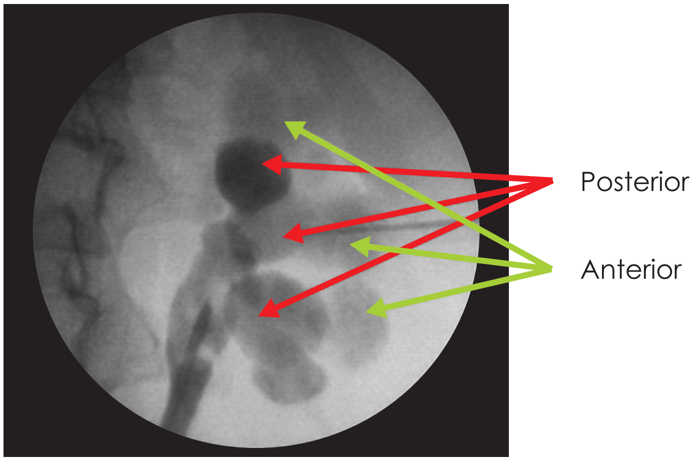

Fig. 15 Position of anterior and posterior calyces

Key points

In practice, due to stone disease or otherwise, different variations of internal renal cavity are seen thus plan to remove stones varies from individual to individual. In general;

- In kidney with wider calyceal necks and complex stone least number of channels is required, even one channel may be sufficient as the broken fragments or small stones can be manipulated easily.
- Narrow and long neck calyces in kidney having multiple or complex stones and calyces present at right angle to the renal entry point may need more channels.

Position of the kidney

It should be kept in mind that kidney lies at 30 degrees to the body while observed through frontal plane (Fig. 16). This is important while puncturing the anterior or posterior calyces. Retroperitoneal approach is adapted for the percutaneous channel. Direction of puncture should be from dorsolateral to ventromedial.

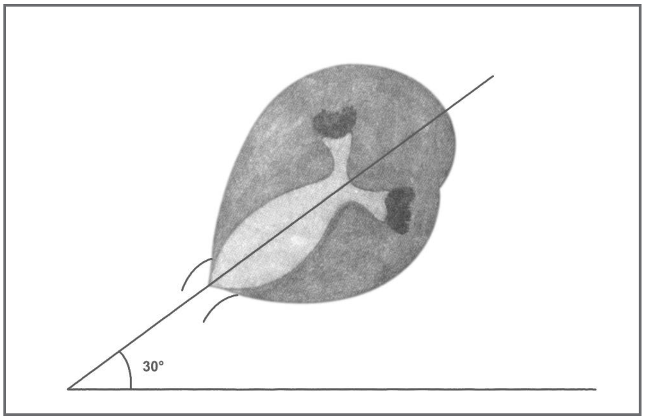

Fig. 16 Angle of kidney relevant to body

The blood supply of the kidney should also be known.

Renal artery divides into two branches in the hilum of the kidney; anterior and posterior. Anterior branch further divides into apical branch supplying to the upper pole, anterosuperior, anteroinferior and inferior segmental branches supplying the anterior half of the kidney. Posterior branch supplies blood to the posterior half of the kidney.

Branches from the anterior and posterior renal artery meet (not anastomose) and an area with relatively poor blood supply results (Brödel line) that runs from the upper to the lower pole. In 70% of the cases this line falls 1-2 cm posterior to the lateral margin while in the others it is on the anterior surface.

Contrary to the renal arterial supply the branches of the renal vein are not segmental and anastomose with each other freely. The rami of the posterior branch drain into one another around the stems of calyces. According to the planimetric examination by Furka and Miko the lower pole has the network of larger and dilated veins as compared to the upper pole. During percutaneous dilation or nephroscopy massive venous bleeding may occur which can be controlled by inserting a nephrostomy drain or balloon catheter.

Cases with mobile kidney, renal ptosis, bifid renal pelvis, horseshoe or malrotated kidney need particular attention while punctured.

If open operation has already been performed mostly tough adhesions develop around the kidney causing difficulty in reoperation. Operation time expands and surrounding organs are more liable to injury. In disease recurrence repeated conventional open operation is difficult to perform and sometimes nephrectomy is obligatory. On the other hand this adhesive fixation is helpful in percutaneous nephrolithotomy because kidney does not slip away, the dilators go straight into the kidney while inserted and the nephrostomy drain remains in place more securely.

The kidney can go through multiple percutaneous interventions. After the percutaneous operation a very thin scar forms at the place of percutaneous channel, there is minimal parenchymal injury and renal function is not disturbed[1].

Among children and young patients it should be kept in mind that kidney can easily slip away while punctured. In such cases more patience, skill and experience is needed. Kidney is fairly mobile in younger age group; it can be pushed or can shift its position during the process of dilation. If open operation had already been performed it is easy to carry out percutaneous nephrolithotomy due to fixation of the kidney. On the other hand in an already operated case the operator should be ready to meet tough adhesions which can change the direction of the needle away from the required one, still it can bend. If puncture succeeds in these cases the adhesions can cause difficulty in dilation and the guidewire can also be broken. It should be kept in mind that colon can be dragged nearer to kidney due to adhesions and gut is more liable to injury while kidney is punctured. On the screen of X-ray image intensifier intestinal gas shadows can be observed and intestinal wall drifting is visible when the needle approaches to it. Colon puncture can be avoided by recognizing this movement.

During percutaneous operation of solitary kidney[2] the highest risk is possible nephrectomy due to serious perioperative complications but this risk aggravates when conventional operation is being performed particularly when the patient is reoperated. According to Streem, complications of percutaneous nephrolithotomy are fewer and have lesser intensity as compared to open operations. Bleeding is the most frequent complication which may lead to nephrectomy. If the patient is in skillful hands only 1% of the haemorrhage patients need transfusion while according to our experience with 20,000 cases at our centres nephrectomy ratio was only 0.03%.

The other important criterion is the establishment of the renal functions which can simply be recognized by serum creatinine level. After percutaneous nephrolithotomy it is the same or better than the open operation of the kidney.

Indications of the percutaneous operation in case of solitary kidney are the same as those of the patients having both the kidneys intact.

It is important to consider strictly the complaints, kidney functions and the expected results before the patient is operated. Staghorn stones which do not obstruct the flow of urine should not be operated on the basis of X-ray picture alone. In case of solitary kidney with staghorn stone the decision to operate the patient is difficult, particularly if he has already been operated. Or it is better to treat him conservatively. If the stone is not causing complaints and the infection is not of great degree antibiotic therapy is advised on the basis of bacteriological culture. Such cases with staghorn stones can be managed for years in this way. If the stone causes massive purulence, urinary flow disturbance and deterioration of kidney functions decision to remove the stone percutaneously should be taken. All the cases should be judged on individual basis.

Decision to remove the stone was not easy for us in the following case.

A thirty eight years old patient was brought to us on stretcher. His right kidney was operated three times and the third operation was nephrectomy. Reason was the stone formation in the kidney. Left kidney was also operated for two times and once again staghorn stone developed in the renal cavity (Fig. 17). The patient was azotemic (creatinine 246umol/L, urea 18.6 mmol/L) and pyuric and he complained of severe pain in the left kidney region. Urographic picture showed a large impacted stone in the pelvis extending to the calyces. If the patient was not operated, his renal functions would have been deteriorated further, causing death due to renal insufficiency. Percutaneous nephrolithotomy was performed in three sessions to free the kidney from stone (Fig. 18). The renal cavity was irrigated with hemiacidrine solution for 10-14 days after each session because the stone consisted of struvite and carbonate apatite. After removal of the drain urine was free of bacteria while cultured. Laboratory tests showed better renal functions. The patient felt better and he was discharged complaint free. In the follow up period the patient was occasionally pyuric.

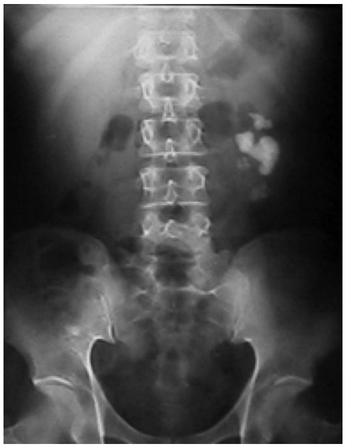

Fig. 17 Left solitary kidney with obstructive renal failure before percutaneous surgery

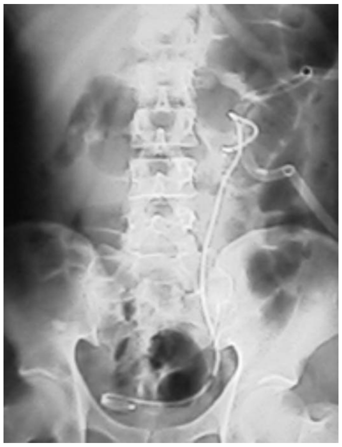

Fig. 18 Same kidney after clearance

Key points

- Relation of stone and anterior/posterior calyx is important while puncturing a calyx
- Internal scar of already operated kidney helps fixating the kidney in terms of mobility while puncturing
- If renal puncture is through the scar, it may be difficult to pierce it through. Balanced force is applied to create the channel to kidney
- In children kidney is too mobile and sometimes it seems to move to opposite side while dilating the channel. Slow rotatory movements are required to enter the kidney
- Solitary kidney with huge bulk of stone can be operated with larger gap sessions if required

According to our Pakistani experience, in case of severe pyonephrosis and complex infection stone, we could save the kidney by irrigating renal cavity with 0.1% Pyodine solution for a few days through two drains placed after percutaneous nephrolithotripsy. Stone recurrence could be avoided by abolishing source of infection and rendering the patient stone free.

In the bifid pelvis though the stone is more common in the upper pelvic cavity (Fig.19, 20), we met with lower pelvis stone (Fig. 21) as well as stones in both the renal cavities (Fig. 22, 23). Upper renal pelvis is situated high so the stone can be approached intercostally through 12th or sometimes 11th intercostal space. While puncturing the kidney particular attention is required to avoid injury to the neighbouring organs (pleura, spleen, liver). Rest of the procedure is the same as that of simple percutaneous nephrolithotomy.

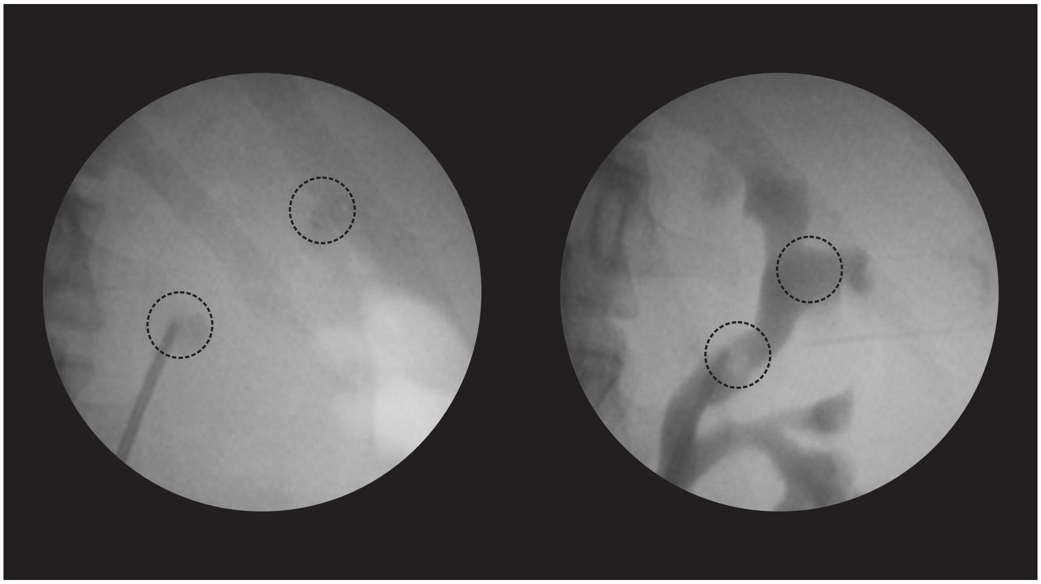

Fig. 19 Stones in the neck and upper calyx of upper system of bifid pelvis

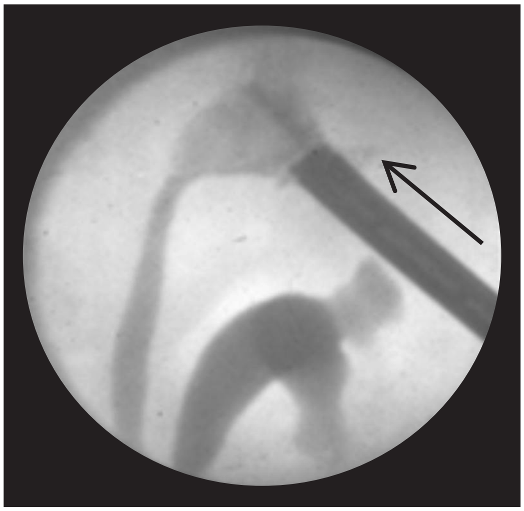

Fig. 20 Upper calyx group stone. Note the angle of entry of nephroscope. This is to avoid high intercostal entry thus avoiding thoracic structures.

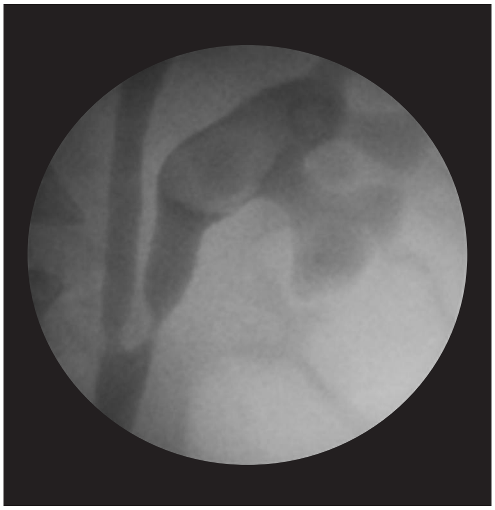

Fig. 21 A stone in lower pelvis

In case of stones in both the cavities of bifid pelvis preferably nephrostomy channel is made so that both the stones fall in one line. Lateral pelvis is punctured, dilation is performed and the stone lying there is taken out. Then the puncture is advanced through the interpelvic parenchyma till the medial cavity, channel is prepared and that stone is also removed. Medial pelvic cavity is drained by a ureteric catheter inserted from below and nephrostomy drain is introduced into the lateral cavity till the urine is clear. The pelvic cavities can also be left without drainage depending upon the situation. Three months follow up IVU examination shows intact internal structures.

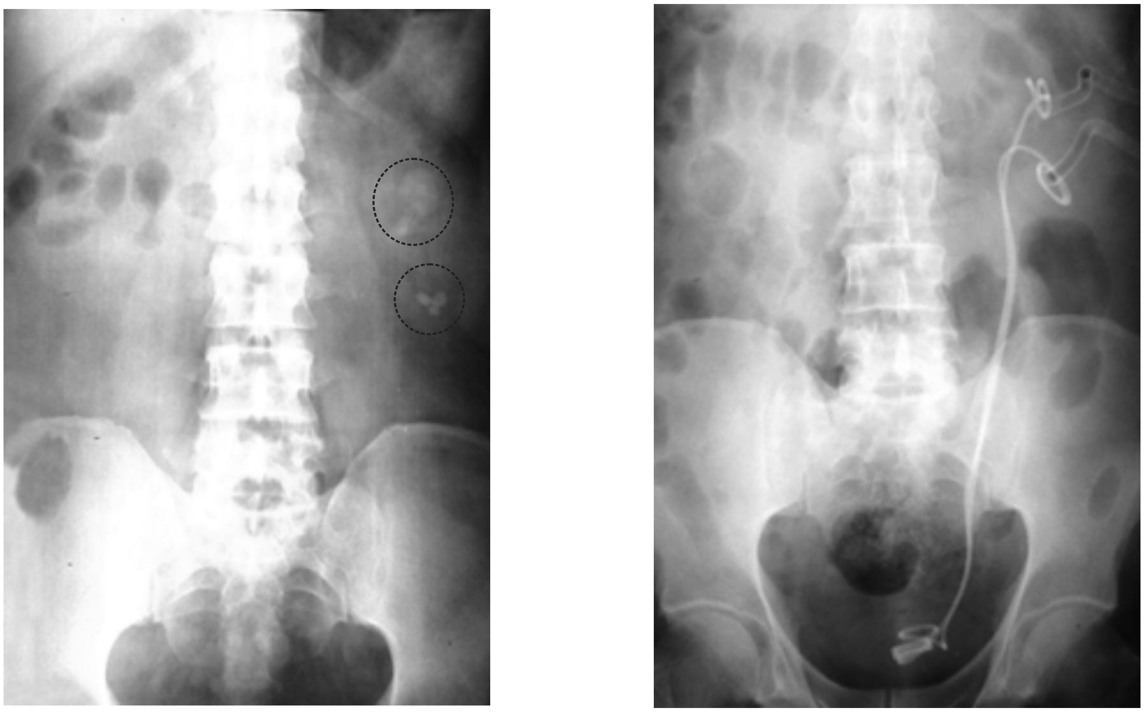

Fig. 22 Multiple stones in both the left renal pelvic systems. It was noted on IVU and nephroscopy that both pelves necks conveyed insufficient downward flow. After stones removal two stents were inserted to improve passage patency.

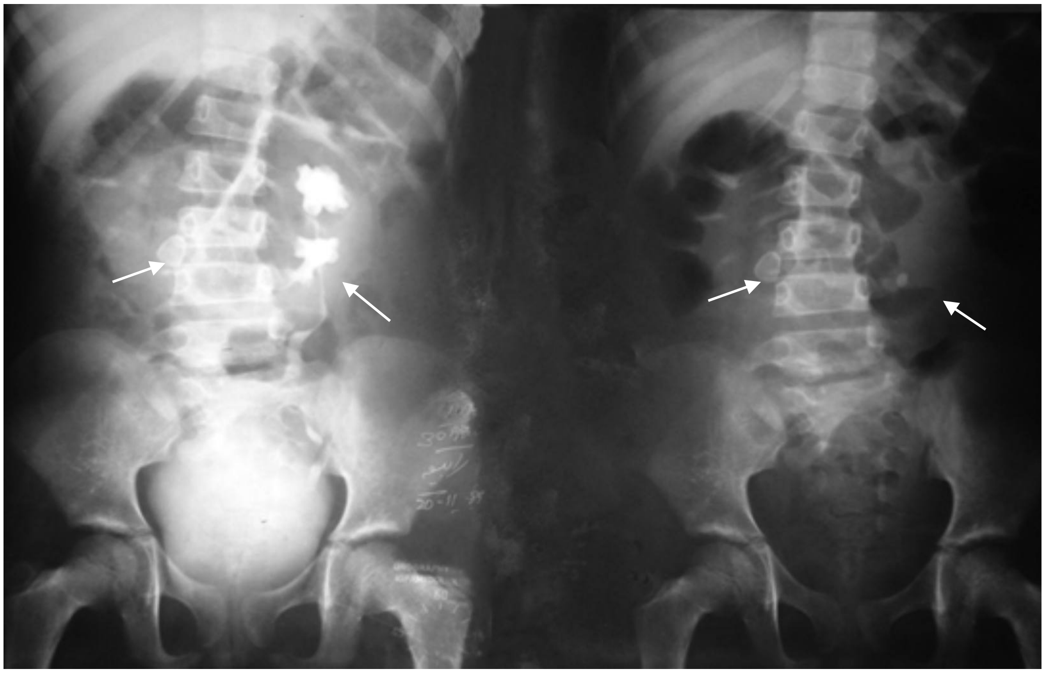

Fig. 23 Both sides have renal stones while left kidney has bifid pelvis and a stone is in lower Pelvis. Right side is non functioning.

Stone is aimed at puncture when it is present in a calyceal diverticulum (Fig. 24). In high-lying case it takes place through the 12th intercostal space. The channel is dilated, nephroscope is introduced into the diverticulum[3] and the stone is removed. The narrow neck of the diverticulum (infundibulum) is traced[4]. If it cannot be seen, blue dye mixed with contrast material is instilled through the retrograde ureteric catheter into renal pelvis. Under the fluoroscopic control its flow is observed through the nephroscope. After detection of the neck guidewire or the guide rod is inserted through it into the calyx or the pelvis. Infundibulum is dilated till 26 F and nephrostomy drain is left inside for three weeks. If the neck is still not found, a new channel is made between the diverticulum and the calyx and dilated and drain is left inside it. This new channel prevents stagnation of urine, infection and stone formation in the diverticulum.

In case of horseshoe kidney[5, 6] (Fig. 25) the following points should be kept in mind.

As compared to normal kidneys the two kidneys in such cases are nearer to each other and placed more caudally. As the renal pelves lie relatively anterior due to incomplete rotation, skin entry point is usually medial to the usual site near the paraspinal muscles. Of course this is a directive principle, exact place and direction of puncture is decided according to the provided situation. Theoretically there may be gross haemorrhage due to injury to the aberrant blood vessels running behind the kidney but we did not experience such complication and could not find such case in the literature available with us.

Horseshoe kidney is sometimes associated with abnormal development of colon. There may be retrorenal colon, posterolateral colon and sometimes megacolon. It occurs in 3-19% cases according to different authors. There is risk of colon perforation during routine percutaneous nephrolithotomy but it increases in such anomalies. While puncturing and dilating channel, intestinal shadow should move separately on the monitor of X-ray image intensifier. It is also worthwhile to mention that posterior calyx group should be punctured preferably in case of horseshoe kidney since it is more medial and dorsal in such cases.

Percutaneous entry point of a malrotated kidney is also relatively medial to usual puncture site. In such a case stones may be found in a calyx medial to renal pelvis (Fig. 26). Approach is mostly through the superior calyceal group.

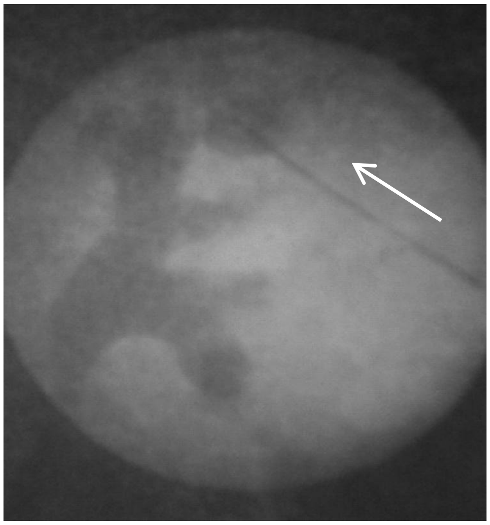

Fig. 24 Needle pointing at diverticulum and the tip stays there while selecting entry point on the skin

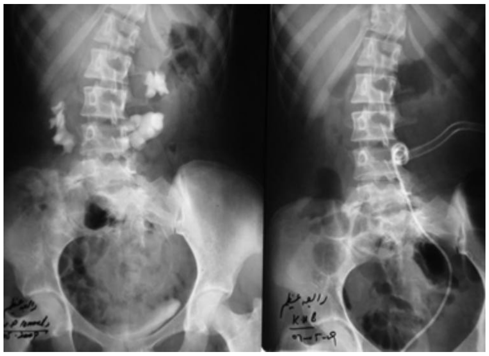

Fig. 25 IVU and postoperative picture of horseshoe kidney. Note its low lying position and incomplete rotation. After PCNL a stent is inserted into the affected kidney.

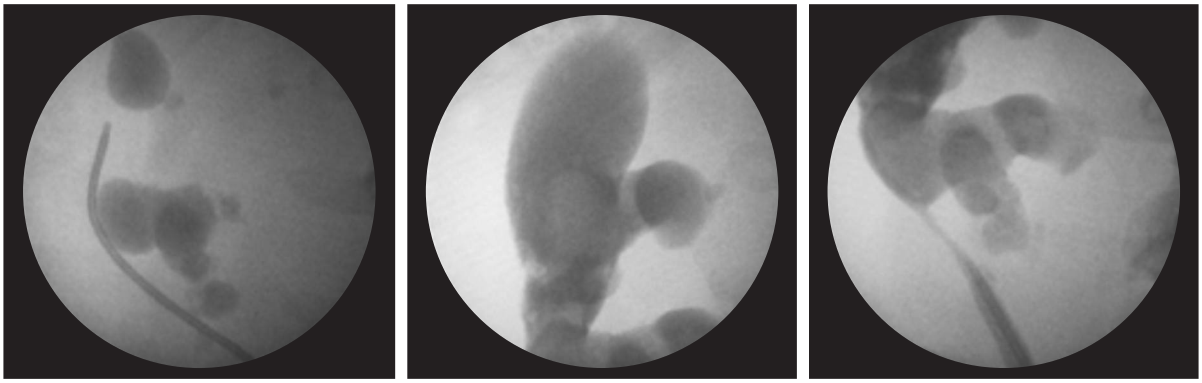

Fig. 26 Calyces lie medially. Size of the kidney is larger than monitor screen as shown in contrast filled kidney. Relation of stones to kidneys should also be noted.

Renal cavity in a horseshoe kidney is irregular, observation through nephroscope is difficult and special attention is required to observe the calyces and ureteropelvic junction. In the dilated and stretched renal cavity the stone can easily be drifted away, may be from upper to lower calyx or into some abnormally situated calyx which aggravates the effort to remove the stone.

Segura[7] (1985) performed percutaneous nephrolithotomy in 1000 cases at Mayo clinic. Among them eight patients had horseshoe kidneys. We dealt with such eight cases among our first 600 cases.

Rarely other pathological lesion is also observed when the stone is removed. It can also be dealt with at the spot. We met one such case when nephrolithotomy was performed. On X-ray picture upper calyx was so much dilated due to a large stone blocking the neck that a tumour inside could not be seen on the IVU film. Tumour of 3 x 3 cm size was observed through nephroscope and was taken out. It was found to be benign papilloma on histological examination. After one year the urographic examination showed intact structures inside. Continuous follow up of the patient is going on by examining his urine and X-rays.

Stones with high matrix content may have small vessels running through stone. Those can be observed on nephroscopy. Such stones are usually impacted and should be dislodged gently from the calyceal wall.

Key points

- In horseshoe or malrotated kidney approach (point of entry) is more medial
- In horseshoe kidney look systematically in calyces having stones. Calyces may lie medial to pelvis and posteriorly than expected
- Preferably upper calyx group is touched to puncture as compared to lower ones in these cases

Kidney stone in children:

Percutaneous nephrolithotomy saves young children from open operation where the incision extends almost half of their side and they have to bear the scar and all its functional, aesthetic and psychological consequences for whole of their life. The youngest boy operated upon was 2.5 months in Hungary while the child was 9 months of age in Pakistan. Both sides can also be operated simultaneously[8] (Fig. 27) and simultaneous renal and vesical stones can also be removed (Fig. 28, 29)

According to our experience kidney of a child is more mobile and it has relatively strong tissues (fibrous capsule, parenchyma, wall of renal cavity). The stone extraction along with puncture and dilation needs attention, experience and accomplishment. Sometimes during puncture and dilation kidney is pushed to the other side as if it crosses the spinal column. In younger age group ureteric catheter is not inserted before percutaneous operation. Infusion urography is performed instead, on the operation table to demarcate the renal cavity. Care should be taken concerning

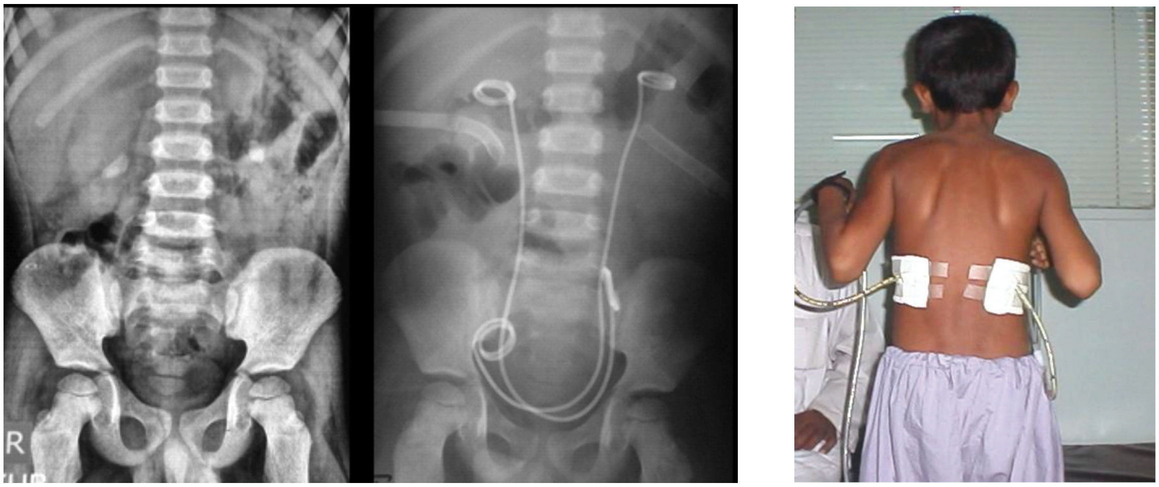

Fig. 27 Six years old boy having bilateral stones. Pre and postoperative X - Ray films.

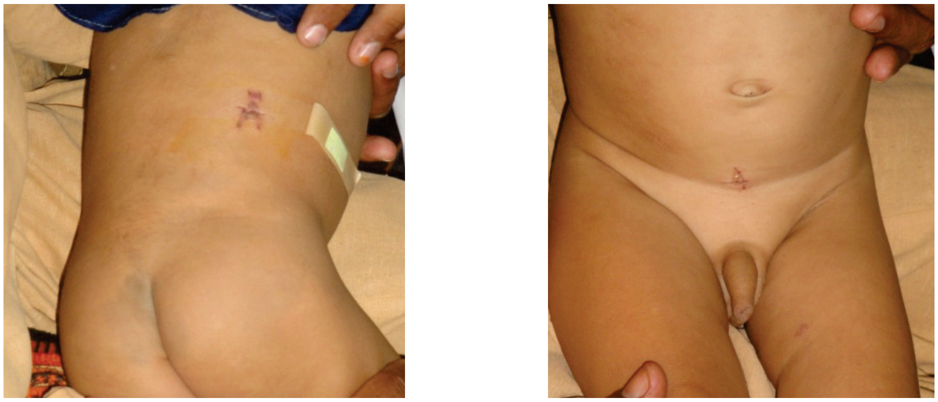

Fig. 28 Two years old boy simultaneously operated for renal and vesical stone

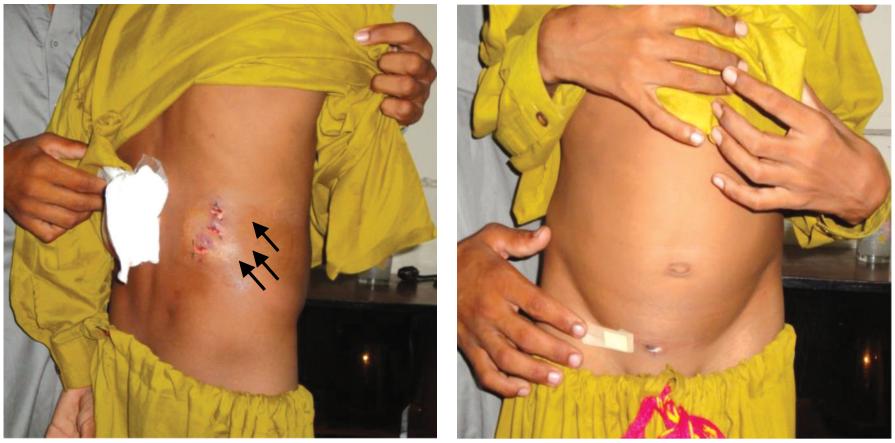

Fig. 29 Simultaneous removal of right renal staghorn (three approaches) and vesical stones

the hazards of X-rays. It is advisable to use gonadal guard and small X-ray exposures.

The method is definitely useful in babies having cystine stone (due to genetic metabolic disorders). Although these stones can be eliminated and prevented with conservative management but it takes longer time and recurrence of stones should also be taken into account. Percutaneous technique can easily replace open operations.

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THE STONE

4

Consideration for percutaneous stone removal depends upon shape, location, size and number of stones. Knowledge of the renal cavity configuration is necessary and position of the stone in it should be known. In other words relation of the stone to the cavity is important. Indication for stone removal does not depend upon the composition of stone but it is influenced by the strategy and technique of its removal for example operative removal of the uric acid stone is indicated if it is tried and could not be dissolved.

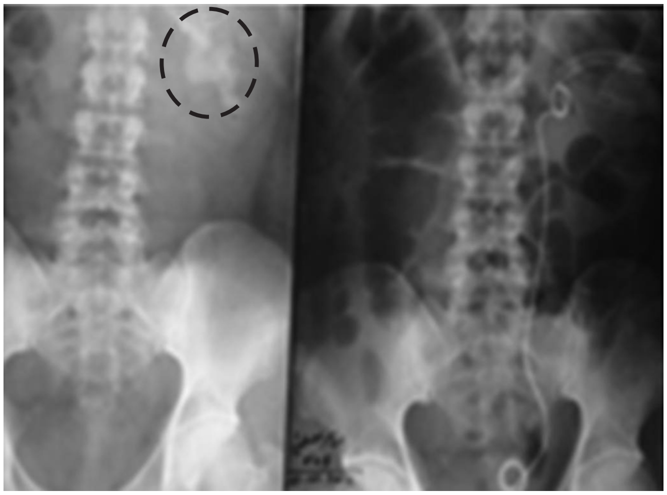
Fig. 30. Pre and postoperative film of a staghorn stone patient

As far as the stone ***shape*** is concerned all the stones can be taken out percutaneously. Even the staghorn stones completely filling the renal cavity can be removed (Fig. 30) but it is worthwhile to have isotope examination if renal function is doubtful. In case of a round stone inflowing water current can sweep away or roll off the stone into another calyx or the ureter. This happens rarely in case of stones having irregular shape.

Location of the stone is ideal for a beginner if it is present in an already distended pelvis (Fig. 31). Stone grasping forceps passes exactly through the dilated neck of the posterior inferior calyx and the stone is caught. If the stone is located in another calyx, it is tried to be brought into an ideal location by fine manipulations and then taken out. After ultrasound disintegration small pieces are brought into such a position from where these can be held with the grasping forceps and taken out easily through the operating shaft of the nephroscope.

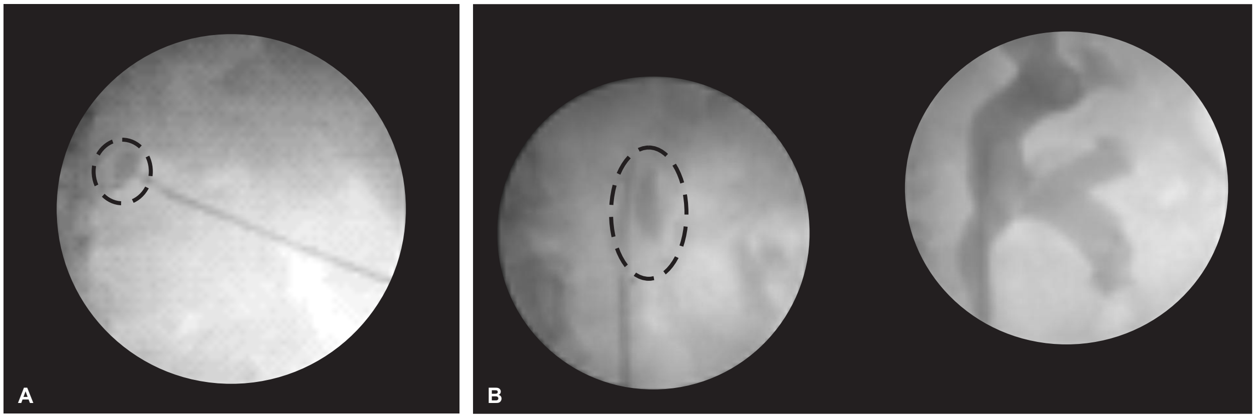

Fig. 31 A & B Solitary stones in dilated pelves

The stone can be removed irrespective of its ***size***[1]. Generally the stones less than 5 mm size are not removed because these can pass out spontaneously. If such stone is found on the plain X-ray film it should be confirmed that it does not have a thick uric acid layer around it which hinders its spontaneous removal. In such cases first task is the trial of stone dissolution.

The maximum diameter of stone which can be removed with 26F nephroscope is 8 mm. Stone of about one centimeter size can easily be removed through Amplatz sheath. Larger stones should be broken into pieces and ultrasonic, pneumatic or laser lithotripter can be used for that purpose.

More than half of 20,000 cases were treated at our departments using ultrasound or pneumatic lithotripter to break the stones. Staghorn stones were also dealt in the same way and some of the stones were so big that those almost occupied whole of the renal cavity (Fig. 32).

Large ***number*** of stones may appear to be a contraindication but it should not be taken into strong account. The number of stones is not so important as compared to their different locations. Numerous stones can be removed from a single dilated part of the renal cavity for example from one group of calyces or spread around in different calyces and pelvis of kidney. Multiple stones in urinary bladder (Fig. 33A) can be removed through natural route or percutaneous suprapubic vesicolithotripsy.

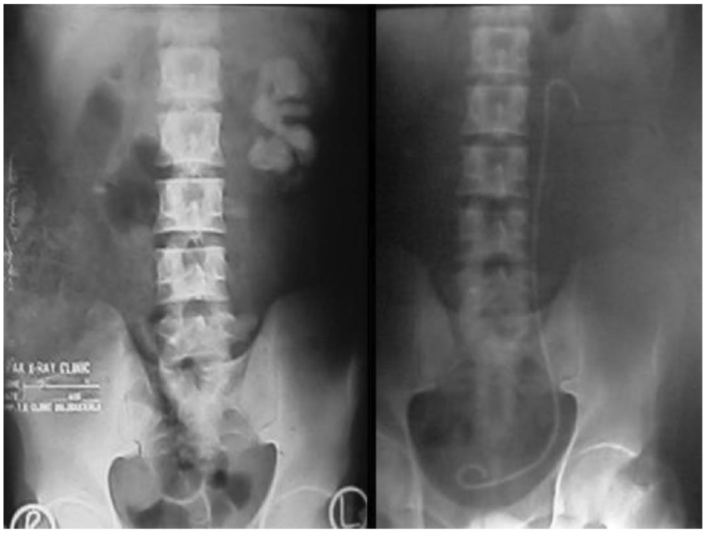
Fig. 32 Compare a clean left kidney and the staghorn stone in it before percutaneous operation

If multiple stones are located in different calyces[2] so that the kidney should be approached from 7-8 different entries, it is not worth operating these multifocal stones percutaneously as monotherapy (Fig. 33B). Further sessions are delayed with longer gap discharging the patient from hospital to come back later on. Aim is not to overstress the kidney. This is particularly true of cases having solitary kidney.

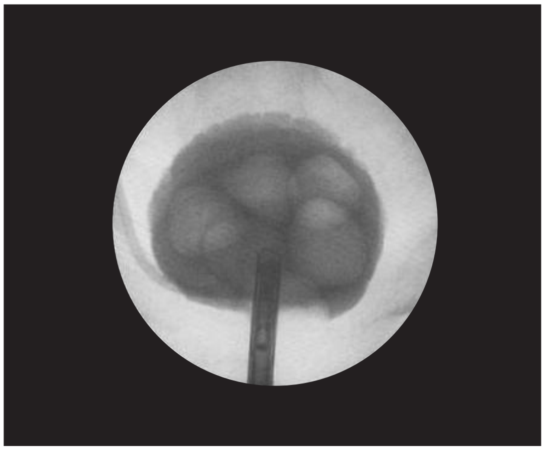
Fig. 33A Multiple vesical stones

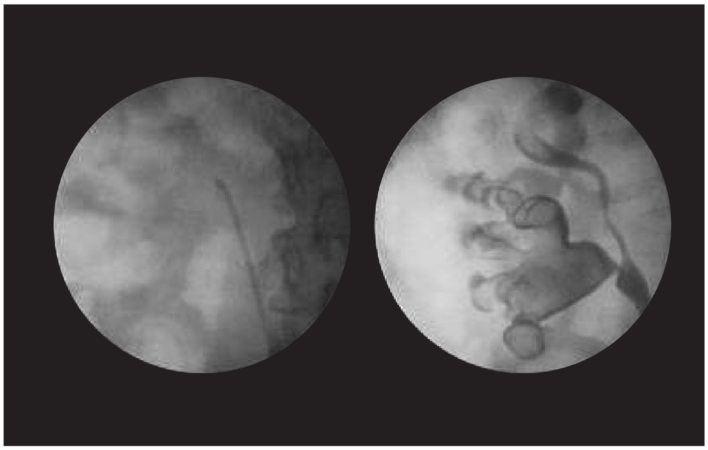
Fig. 33B Multiple stone in complex calyces

Beginners are not advised at all to operate the multifocal stones percutaneously. For them it is better to start with smaller renal pelvic stones.

Now we discuss small stones of 6-7 mm size in a calyx. If the stone is in the bottom of an anterior calyx and the posterior calyx is approached percutaneously, it is difficult to remove that stone. If the stone is lying in the bottom of a calyx and renal cavity is approached through the neck of the same calyx to the pelvis, the attempt to remove that stone will be unsuccessful and its cause is inaccurate puncture. Accurate puncture[3] is required to remove small stone in the bottom of a small axial calyx and it needs great experience. It should not astonish the operator when the position of the stone in the calyx is accurately judged and nephroscope is passed but the stone is not found. If further search is made, small stone can be found behind a large papilla. Sometimes the stone is pushed into the pelvis during the process of dilation and it is not difficult to take it out from there.

Relation of the stone location to renal cavity should definitely be observed before intervention. Operation requirement and its course can be established this way. Stone can be removed successfully if the course of operation is already determined thoroughly. Small stones which can pass out spontaneously and the 'silent' stones are not indicated to be operated until necessary.

All types of stones can be removed percutaneously but the strategy, technique and how much time it will take to be removed depends upon the chemical composition of stone.

If on the X-ray picture white spot of strong intensity having plain surface is seen, it is whewellite (calcium oxalate monohydrate) stone. On nephroscopy it is dark brown and oval shape stone (Fig. 34, Fig. 65) and has a crater like dip on it in most of the cases. It is hard stone and can barely be scratched by grasping forceps. This type of stone takes the longest time to be disintegrated but it may be only minutes depending upon the size of stone. The stone can easily slip away from the ultrasound probe due to its plain surface so it should be strongly supported to the opposite wall of the cavity. Large pieces of such stone should be split further so that the removal becomes easy. Radiant layered structure can be seen on the broken surface which is characteristic of whewellite stone. There is less possibility for the small stones to remain inside. If the stone size is ideal (not larger than one centimeter) the operation can be completed within five minutes. We do not leave nephrostomy drain inside among such cases.

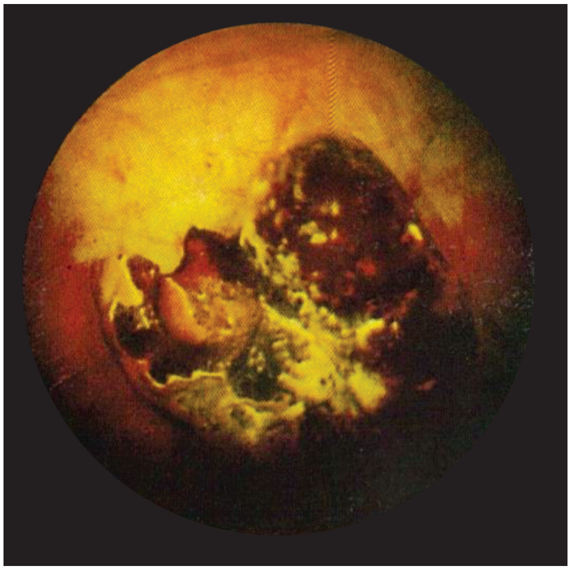

Fig. 34 Calcium Oxalate Monohydrate (Whewellite) stone. In Fig. 65 broken hard and layered fragments are present in a tray.

Weddellite stones (calcium oxalate dihydrate) have loose structure which can be seen on the X-ray picture. Its crystals are arranged in a wheel spokes pattern and the stone is very fragile with uneven surface so it should be held carefully with the forceps. Through nephroscope typical spear like, glassy, sharp and loosely adhering grey crystals can be seen (Fig. 35). It is sufficient to touch lightly with ultrasound probe because crumbling of stone takes place within one to two seconds. If the probe is pushed into the stone strongly and for a longer time, the stone turns into debris. Even if we try to suck debris from all the recesses, residual crystals remain inside and this process prolonges the operation time.

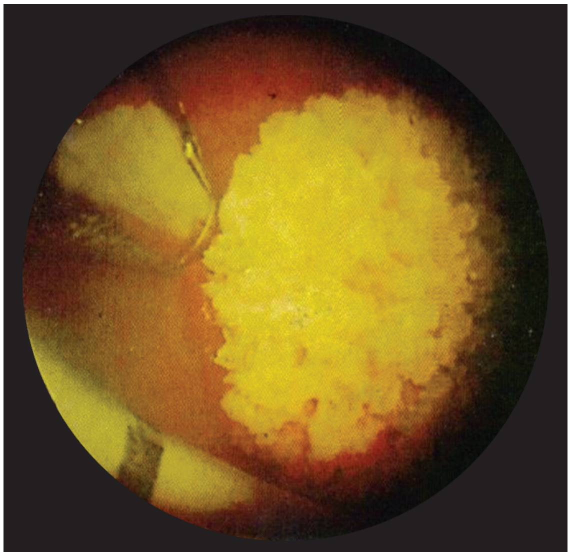

Fig. 35 Calcium Dihydrate (Weddellite) stone.

Struvite (Mg NH_4 PO_4 hexahydrate) and carbonate apatite stones have grey white surface and generally grow to large size but may also be small and friable (Fig. 36, Fig. 65). In the latter case these can be broken into pieces mechanically by the grasping forceps. Large stones should be disintegrated ultrasonically[4]. Soft stones turn into powder and this sludge like material is sucked by the ultrasound apparatus during the process of disintegration. By this means a lot of time can be saved because small particles are not to be collected one by one.

Large hard staghorn stone may take hours because very small pieces can be taken out by suction and larger pieces should be removed with the help of forceps one after the other. It is not rare that 2-2.5 hours are required for one session after which second and third session is also necessary to clear the kidney from stone. Stone-wash technique is mentioned at another place for such stones. In case of struvite (infection) stone two drains are left inside for irrigation with hemiacidrin solution after complete removal of stone.

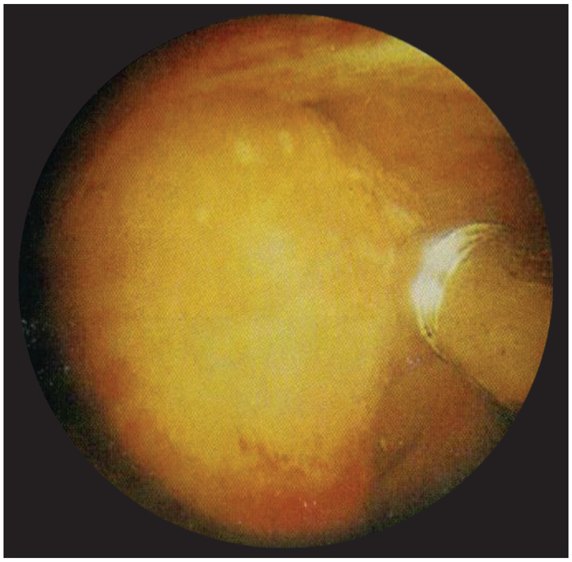

Fig. 36 Struvite + Carbonate Apatite (Infection) stone. In Fig. 65 friable greyish white fragments in a pile after crushing and removal.

Uric acid stones are radiolucent and mostly as hard as whewellite stones. They frequently take long time to break with ultrasonic or pneumatic lithotripter. Rarely these have softer consistency and take short time to be crushed. If oral dissolution is tried long time may be required for stone to dissolve. It is worthwhile to remove such stones if there are frequent relapses of spasmodic pain due to stone impaction and renal damage is expected as a consequence. These can be observed through nephroscope having reddish yellow colour and annual-ring like layers (Fig. 37). Such stones can be broken into smaller pieces and taken out but if small particles remain inside, these can be eliminated with oral or local dissolution agent.

Even if the urine is sterile, two nephrostomy drains are left inside and the cavity may be alkalized with tris-buffer saline (Liotris) for days. After complete stone removal allopurinol therapy is started as prevention.

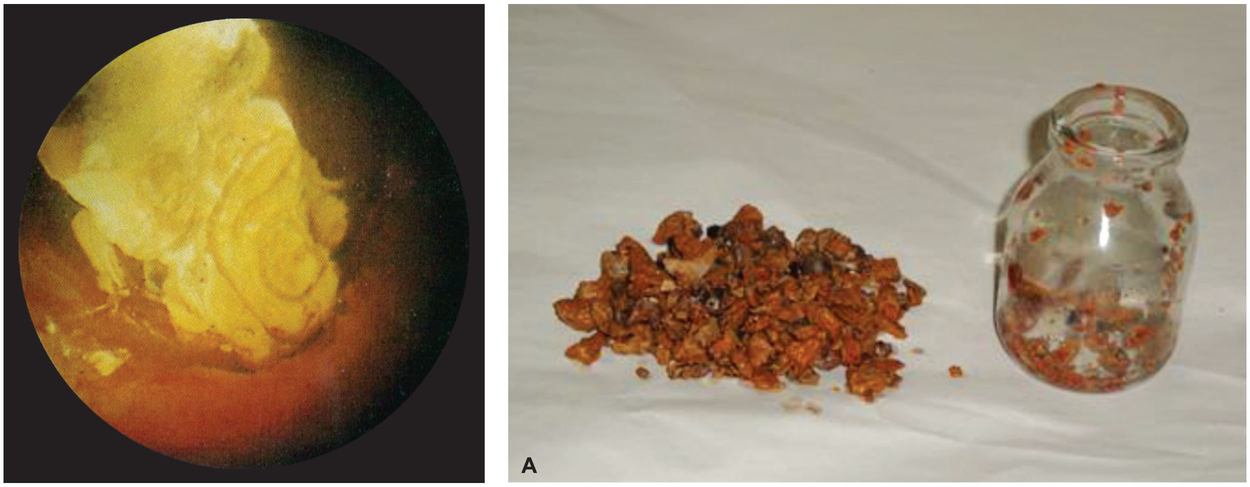

Fig. 37 Uric Acid stone A. Fragments after removal

Brushite (calcium phosphate) stones are greyish white hard stones forming in the acidic urine. Cystine stones also form in acidic urine. These are wax coloured hard organic stones (Fig. 38). Both the types take longer time to be crushed by ultrasound due to hardness. Residual fragments of cystine stones, like uric acid stones, can be dissolved by the renal irrigation with local agents (Tris buffer, N-Acetylcysteine). Cystine stones are rare.

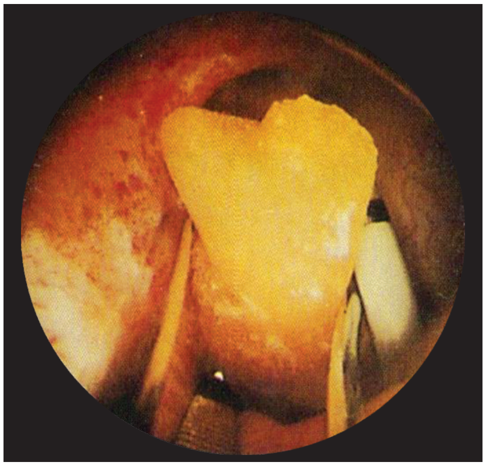

Fig. 38 Cystine stone. Wax shape

The cause in case of suture stone (Fig. 70) or foreign body stone[5] is known. If the cause (foreign body, infection) is removed stone recurrence can be stopped.

We found stents in 15 cases, suture material in five cases, a piece of surgical needle, a portion of the Foley catheter balloon in one case, a pear shape stone on the IUD inside the urinary bladder and in another case stone formed at the end of Thiemann catheter in the kidney.

Ratio of stone composition in Hungary as well as in Pakistan can be seen in Fig. 39.

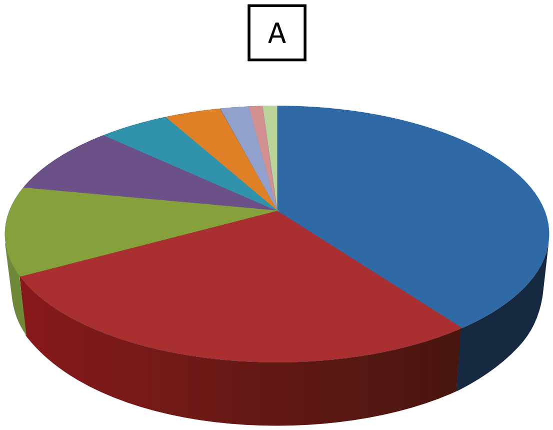

Fig. 39 Types of stone according to chemical composition. A. Hungary B. Pakistan.

1. Whewellite + Weddellite	40%
2. Whewellite	27%
3. Struvite + Carbonate apatite	11%
4. Ca Ox + Struvite + Carb. Apatite	9%
5. Weddellite	5%
6. Ca Ox + Uric acid	4%
7. Uric acid	2%
8. Struvite + Carb. Apatite + Uric acid	1%
Cystine + Brushite matrix	1%

1. Calcium oxalate + Uric acid	46%
2. Calcium oxalate	21%
3. Calcium oxalate + Phosphate	15%
4. Calcium + Magnesium + Ammonium + Phosphate	6%
5. Uric acid	5%
6. Calcium oxalate + Phosphate + Uric acid	3%
7. Calcium oxalate + Ammonium urate	2%
8. Calcium oxalate + Ammonium + Phosphate + Uric acid	1.5%

Key points

- Small stones can easily be drifted away with flow. Inflow tap can be reduced to half to reduce fluid current.
- Round and smooth surface stone can slip away when probe rests on it. Ultrasound probe incorporated with suction can help it keeping nearer while creating a groove that helps it staying at one place. It is pushed to opposite wall while breaking.
- During pressing of hard stone to opposite wall, inflamed pelvic wall can be disrupted and stone can fall out. Frequent change of place of stone and not pressing too much is the remedy.
- There is more chance that small broken radiolucent fragments remain inside as compared to radiopaque stones.

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EQUIPMENTS AND PERSONAL CONDITIONS IN PERCUTANEOUS SURGERY

5

OPERATION THEATRE

Theatre is the same as for general surgery but there should be the possibility to darken it. Preparations are the same as for the open operations. At some institutes percutaneous procedure is performed at department of radiology partly due to the reason that radiologists started percutaneous interventions. Still the radiologists start with puncture and dilation of channel and urologists introduce nephroscope and remove the stone at some centres. We perform complete procedure, from channel making to stone removal, in the operation theatre by ourselves as it is being done at many other places.

Generally, maintenance of sterilization is hardly possible in the X-ray department. Not only that the available space is unsuitable for this purpose but also other procedures are being performed at the same place. Unrestricted movement of different patients is another factor which makes it difficult to perform percutaneous operations at radiology department. Rarely immediate surgical intervention is necessary due to some complications (e.g., massive bleeding) during the procedure and fully equipped operation theatre is needed. Unfavourable surroundings may endanger life of the patient.

X-ray image intensifier is a necessary component of the operation theatre (Fig. 40). Different types of single dimension machines are available in the market but such apparatus is more useful which gives picture from more dimensions. C-Arm image intensifier is made for that purpose. Only the image intensifier is sufficient for puncture and dilation, to know the location of the stone in the kidney and its relation to the cavity. At the end of the procedure renal cavity can be filled with contrast material and its flow through the ureter into the bladder can be observed. For safety against radiations[1] all the persons who work in the operation theatre should wear lead apron. Lead guard is placed under the gonads of the patient. Effective protection from radiation is ensured by small exposures. Gradually with experience, it is possible to go through lesser radiation load.

Lead aprons should be present in the theatre in sufficient number to save all the individuals from radiation exposure.

Operation table top should be made up of radiolucent material for the use of X-ray apparatus.

It is good if the diagnostic ultrasound apparatus is available but it is not a necessity. With the help of this apparatus puncture can be made and the needle can be directed into the required part of the cavity. In spite of its accuracy it is possible that the needle does not enter the required calyx. Then fluoroscopy is of help at this spot. Advantage of ultrasound is that the puncture is most often correct and is radiation free. Ultrasound guided puncture is also useful for inserting nephrostomy drain in an obstructed kidney when it is not outlined by IV contrast material or the retrograde urography cannot be performed.

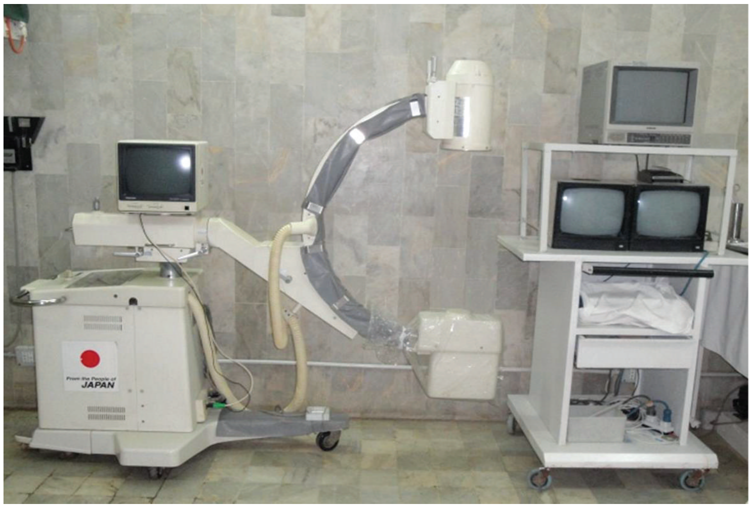

Fig. 40 C-Arm Image intensifier

Presence of illuminator in the operation theatre is important to observe the necessary X-ray films during the operation.

SET OF INSTRUMENTS

Special set of instruments is required for percutaneous renal surgery. At our departments mostly the instruments used are from Karl Storz of Germany. Puncture needles and guidewires are from Surgimed, Cook and Angiomed. The light source and cables are from Karl Storz which can also be used for transurethral procedures.

Cystoscope:

Any type of cystoscope is good by which the ureteric catheter can be inserted up into the pelvis of kidney having stones. 70° telescope with deflector mechanism is the best to insert a ureteric catheter through rigid cystoscopes but after some experience 0° can also be used.

Ureteric catheter:

Mostly 7F catheter is used by us among adults. Smaller calibre is used when 7F does not pass up due to some constriction or if required, among younger children. Use of balloon ureteric catheter is advantageous if it is available. It solves two purposes, for retrograde instillation of contrast material while puncturing renal cavity and to occlude the ureter during stone breaking from fragments to pass down.

Foley's catheter:

It is introduced into the bladder at the beginning of operation or after ureteric catheter has been inserted in to help draining urine and irrigation fluid. Ureteric catheter is fixed to it with the help of a tape or by a knot to avoid its slipping during the movement of the patient. Urine bag should be checked frequently during operation because it may fill up, bladder cannot be drained and the patient feels distress.

X-ray contrast material:

5 ml indigo carmine or methylene blue dye is added to 250 ml of diluted contrast material and it is attached to the ureteric catheter with the help of infusion set. Non-ionic material is used if the patient is contrast allergic. Generally it is allowed to drip down at the time of puncturing or moderate pressure is applied if renal cavity is to be dilated.

Needle, syrings and local anaesthesia:

40-60 ml of 0.5% procaine or 0.25% pure xylocaine solution is used for local anaesthesia if this mode is chosen to desensitize the area during operation. It is started from skin and it is injected slowly by pushing the needle till the fibrous capsule is reached. In this way such cylinder like anaesthetised area is found till the kidney through which percutaneous operation can be performed painlessly and securely.

The patient feels momentary mild pain when the fibrous capsule is dilated, when the needle enters the calyceal base (papilla) or when the renal cavity is stretched due to overfilling. The patient should be informed about it before the operation.

Pointed scalpel:

It is used to incise the skin for about one centimeter.

Puncture needle:

Different types of puncture needles are available in the market. Mostly we use Günther type fine needle (Fig. 41) in Hungary. This needle has three coaxial parts. Its external diameter is 0.7 mm and it is 20 cm long. It causes minimum parenchymal injury even if the puncture is tried more than once. With such needle dilated renal cavity can be punctured even for 6-8 times without much damage. If such needle is not available, long and thin lumber puncture needle may be used for the same purpose. In Pakistan we use simple long puncture needles that are freely available.

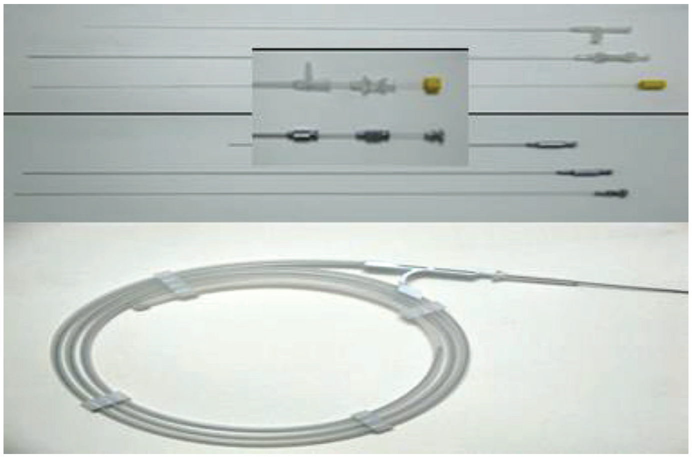
Fig. 41 Needles and guidewire.

Guidewire: (Fig. 41)

Different guide and glide wires are available in the market. Lunderquist guidewire is used in most of the cases. It has plain surface. It is semi-rigid but has got flexible end of 5 cm. It is 80-90 cm long. Completely flexible wire with Teflon coating with spiral surface is used only when the above mentioned wire is not available.

During the learning phase it is better to use two guidewires at the same time. To be secure, flexible thin teflon coated guidewire can be used along with Lunderquist wire. Later on only one wire may be used.

Main guidewire can be removed after introducing the guide rod. Possibility of bending or breaking the guidewire is reduced by such manoeuvre.

Teflon fascia dilators:

These dilators are of 10, 12 and 14F size. These are slid over the guidewire consecutively one after the other. Their function is to dilate the percutaneous channel across lumbodorsal fascia, adipose tissue, fibrous capsule and the renal parenchyma till the base of the calyx is reached. These are slid over the guidewire one after the other. Preferably these should not enter the renal cavity because after their removal leakage of contrast material causes observation difficulties on the screen.

Metal fascia dilators: Fig. 42A

These serve the same purpose as Teflon fascia dilators. Two in number, internal one has sharper end and longer than the outer sheath. After inserting guidewire, needle is removed and these dilators are inserted by rotatory movement, taking care that the guidewire is not bent. Trick is that it is pushed in by keeping the internal end relatively towards dorsum of the patient in prone position with one hand while guidewire is held with the other hand and keep it straight by stretching a bit.

Amplatz dilators:

When used, complete dilation is performed with these teflon dilators till the required dilation is achieved to insert nephroscope.

Even if the dilation is performed with metal coaxial dilators, in case of large broken fragment, 30F Amplatz sheath is used with the same 26F nephroscope to take 9-10 mm stones out.

Telescope metal dilators:

The first one in this series is hollow guide rod having globule on its one end (Fig. 42B). This end is directed into the renal cavity. Diameter of the globule is 1.95 mm. The length of the rod is 580 mm and external diameter is 1.3 mm. Whole of the set consists of 9, 12, 15, 18, 21 and 24 F size dilators and these can slip over each other. Their special form hinders their inwards over-slipping (Fig. 42C).

Operating sheath (shaft):

Mostly used size is 26F and it is a metal tube. Continuous irrigation and suction can be performed (Fig. 42D). One of the taps allows the fluid to go in and the other one serves for the drainage. Flow of irrigation fluid can be regulated manually by controlling these taps. It has centimeter markings on it by which its depth into the body can be judged. Its form helps irrigation in such a way that renal cavity does not rupture due to overpressure of irrigation fluid.

Nephroscope:

Different types and sizes of rigid nephroscopes are available. Considering shape right angled eye piece and 45° eye piece are common. We use right angled Alken-Hohenfellner type nephroscope (Fig. 42E).

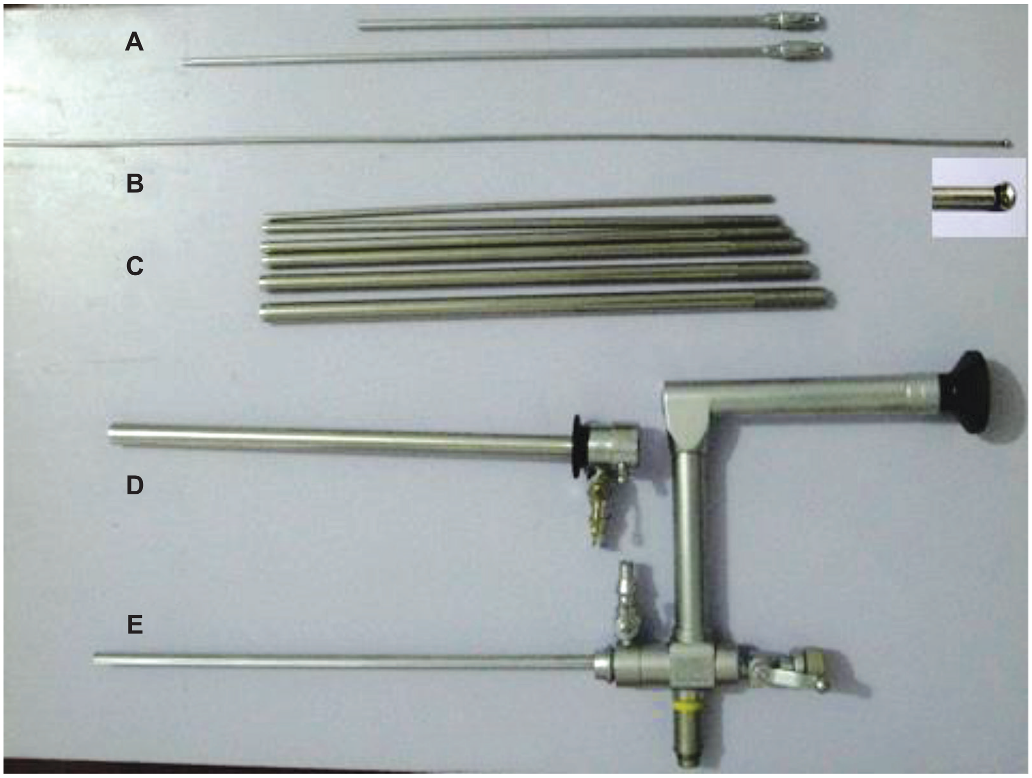

Fig. 42 A. Two Fascia dilators
B. Long rod with globule end (enlarged). This end is directed inwards.
C. Dilators are slipped over guide rod.
D. Nephroscope sheath is passed over the largest caliber dilator and dilators are taken out along with rod.
E. Nephroscope telescope is inserted into the sheath.

Basic nephroscope has three channels. Optical channel, light channel and the instrument channel (Fig. 58).

Optical channel consists of lens system which ensures complete view of the inner aspect of renal cavity. It is accompanied by the light channels on both sides. Light from the external source is conveyed into the renal cavity through the incorporated fibreoptic light transmission system in these channels. Below the optical channel is the instrument channel which is open at the lower end. The external opening can be closed with a tap and its end can be plugged with a rubber cap sealing. Through this channel ultrasound probe, different types of stone grasping forceps, endoknife, Dormia basket and other instruments can be driven into the renal cavity. Karl Storz`s Hopkins 0˚ telescope gives good internal look. Field of vision is kept clear by irrigating the cavity with sterile fluid. Generally normal saline is used for that purpose. Lack of irrigation causes difficulties in observing the interior of the cavity.

Light source:

Different light sources can be used to lighten inside the renal cavity and the halogen is the common one having 150W halogen bulb in it. There is a knob on it or buttons to control its intensity. Halogen light is sufficient to perform different endoscopic manoeuvres and photography.

Light cable:

The light cable is connected to the nephroscope and it transmits light from the light source. Different sizes in diameter are available. Larger the diameter of the cable better is the light transmission and thus the view is better. Fibreoptic lenses or the fluid is used in these cables as the medium for the transmission of light.

Irrigation fluid:

Use of sterile isotonic normal saline solution is very important for the purpose of irrigation. If the irrigation fluid is not isotonic and its larger quantity accumulates in the retroperitoneal cavity, it may cause serious complications similar to post TUR syndrome. The fluid reservoir should be kept approximately 70-90 cm above the kidney level.

Rubber tubes for irrigation:

The flow of irrigation fluid is established with the help of these tubes. Diameter of the tube leading to the nephroscope is about 5 mm and it extends from the reservoir to the nephroscope. It is furnished with a stop cock. The outflow is maintained through another tube which extends from the tap of the outer sheath of the nephroscope to the fluid collecting reservoir beside the operation table. Caliber of both the tubes is the same. Our experience shows that the passive flow through these tubes is better as compared to the connection with the suction mechanism.

Lithotomy forceps and equipment for stone extraction:

Grasping forceps with three expanding jaws (Fig. 43A): It is frequently used to remove large pieces of stones.

Biopsy forceps (Fig. 43B): Mainly meant for taking biopsy. It is also used for the blood clots and the stone fragments sticking together.

Coagulum Forceps (Fig. 43C): It is used for the blood clots and the stone fragments sticking together.

Grasping Forceps, Alligator type (Fig. 43D): This is also used to remove stone particles. Its grip on the stones is strong enough but too much pressure should not be applied while grabbing the stone and taking it out. The jaws can be broken.

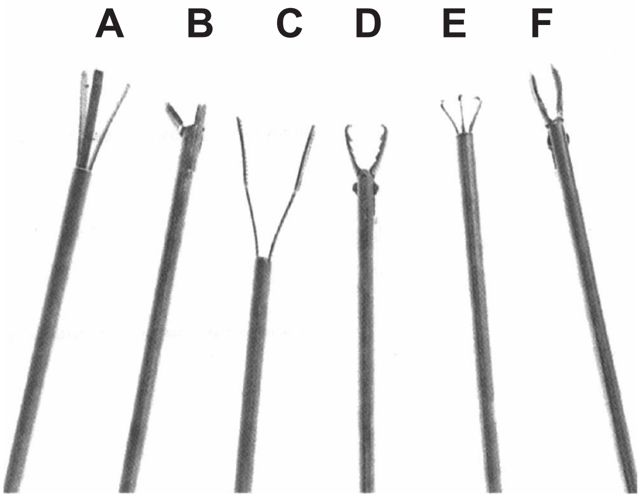

Fig. 43 Different forceps used in percutaneous surgery

Fine Forceps with Three Expanding Jaws (Fig. 43E): Impacted stones at the ureteropelvic junction or the stones in the upper part of ureter can be removed with it. Due to its sharp jaws it can cause mucosal injury or perforation so it should be used carefully.

Forceps, Peanut type (Fig. 43F): Fine Forceps to remove stone debris.

Ultrasound Generator and Probe, Suction set: It can be turned on with a footswitch. It sucks the stone debris through the main channel of the probe when the ultrasonic stone disintegration[2] takes place and shifts it to a bottle already having fluid in it. As compared to electrohydraulic lithotripsy its advantage is not to injure the soft tissues and the debris can be sucked out at the same time. Bore of the probe can be selected depending upon the hardness and the size of the stone. Though the flow of fluid through probe restrains it from warming but when compared with other methods of stone breaking like pneumatic lithotripsy, earlier wearing out of nephroscope lens system is noted. High temperature generation during stone breaking affects the nephroscope.

Sickle or straight Endoknife: Stricture of the ureteropelvic junction can be incised with it. It is guided into the pelvis through the instrument channel of the nephroscope and the strictured wall is incised under direct vision (Fig. 44, Fig. 68).

Optic Triradiate Stone Grasper, Wickham-Miller Type: Small stones, in complete, can be removed from a relatively dilated pelvis with the help of this type of nephroscope which has incorporated forceps.

Kidney Stone Punch: It is used when the stone is larger than the bore of nephroscope sheath. Stone is crushed mechanically into smaller pieces and taken out.

In the presence of regular nephroscope and stone disintegration mechanisms (ultrasonic or pneumatic) Wickham-Miller type nephroscope or punch are not much used in kidney stones. Main utility of stone punch remains with urinary bladder stones, if used (Fig. 90).

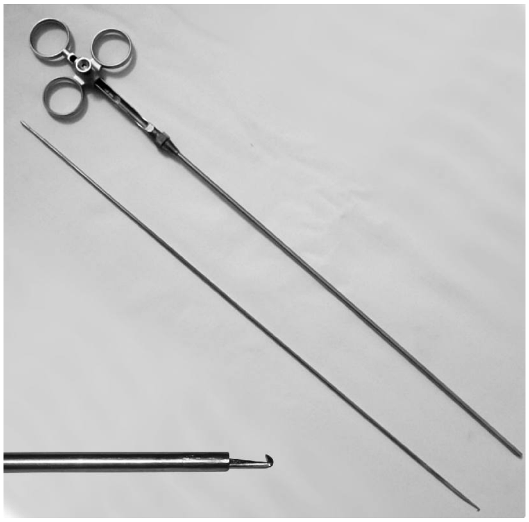

Fig. 44 Endoknife with sickle end. Straight end is also available. Either can be used according to situation.

Nephrostomy Drain Tube: It is made up of polyethylene having a diameter of 18-20F and one or two holes at one end. This end is placed inside the pelvis or the upper calyx. External end is attached with a urinary bag. Malecot catheter can also be used. Foley catheter can be used for that purpose by cutting its end and not inflating the balloon but due to its soft texture it can slip out of kidney easily.

Needle, Needle Holder and Suturing Material: These are required for fixation of nephrostomy drain after the operation.

Irrigation Syringe with Contrast Material: Regular nozzle syringe can also be used for that purpose. After the operation renal cavity is filled with contrast material through the nephrostomy tube. Inside relations, residual stones, extravasations, and perforation injuries are checked under fluoroscopic control.

If gas sterilization is used the instruments should be fixed 72 hours earlier. These instruments can also be used after disinfection (e.g. with Cidex solution) and rinsing before operation. Steam autoclaving can also be used for this purpose but the equipment should be autoclavable.

According to our experience, even if the instruments are autoclavable, life of lens system incorporated equipment decreases by autoclaving as compared to disinfecting those with the disinfectant solution.

Though one can start working with above mentioned equipment, more sophisticated and effective equipment has also been invented having the advantage of minimal invasion, more efficient laser stone breaking combined with tissue coagulation and easier entry and manipulation in the ureter. Some of those technological improvisations are given at the end of this chapter.

FUNCTION OF O.T. ASSISTANTS

Contents of the tray for the percutaneous renal stone surgery prepared by the OT nurse:

- Syringe for local anaesthesia
- Needle for the syringe
- Long needle 20 cm.
- Procaine/lidocaine 0.5% solution
- Scalpel with sharp blade
- Puncture needle (Günther type) or long / lumbar puncture needle
- Guidewire
- Teflon dilators 10, 12,14F, or metal fascia dilators.
- Guide rod 9F, and metal dilators set of 9. 12, 15, 18, 21, 24F
- Operating sheath 26F
- Nephroscope
- Light cable
- Irrigation tube for fluid inlet and reservoir
- Tube for fluid outlet

- Ultrasound probe (2pcs.) and transducer / pneumatic lithotripsy handset and probe.
- Wrench
- Stone grasping forceps

OT assistant should take care and prepare the following:

- Operation table
- X-ray image intensifier. The cable and foot switch should be covered with water proof sheet.
- Contrast material with indigo carmine or methylene blue dye in it should be ready on a stand beside the table.
- Normal saline solution for irrigation. It should be warm enough.
- Ultrasound generator, suction apparatus, foot switch with cable and the ground connections or pneumatic lithotripter set.

They should also know the use of the instruments for the ureteric catheter insertion and the regulations of its use.

Key points

If affordability is an issue, to start with, following equipment is necessary in nephroscopy;

- Puncture needle – Long puncture needles of different sizes.
- Flexible guidewires – Frequently available in the market.
- Nephroscope – One of the two types parallel or angled eye piece Size 26 F
- Dilator set –
    - Metal Fascia dilators.
    - Metal channel dilator set along with rod.
    - Among Teflon dilators 30 F Amplatz sheath along with its obturator is good to take one cm fragments out.
- Forceps –
    - Triradiate forceps.
    - Alligator forceps.
- Endoknife – Both blades are good to have. Sickle and straight
- Lithotripter probes – Ultrasonic or pneumatic. Two are good to have at a time.

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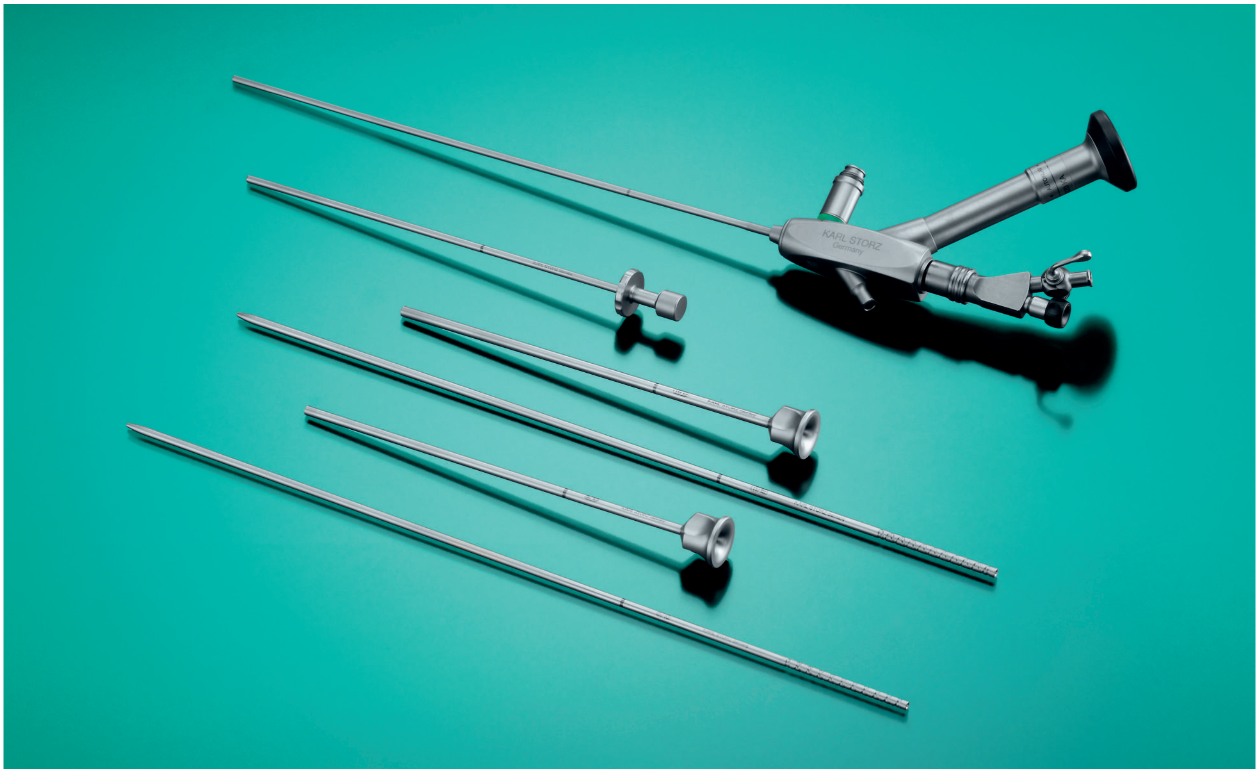

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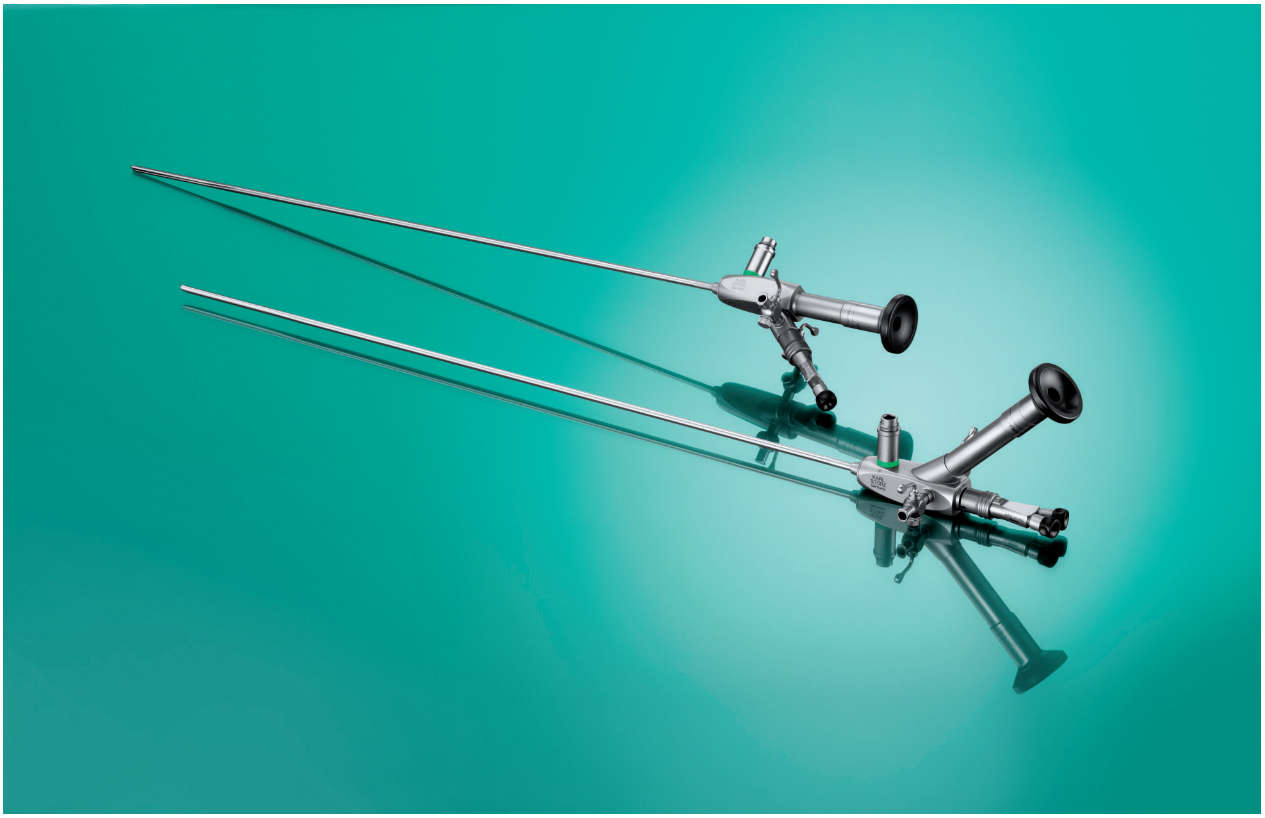

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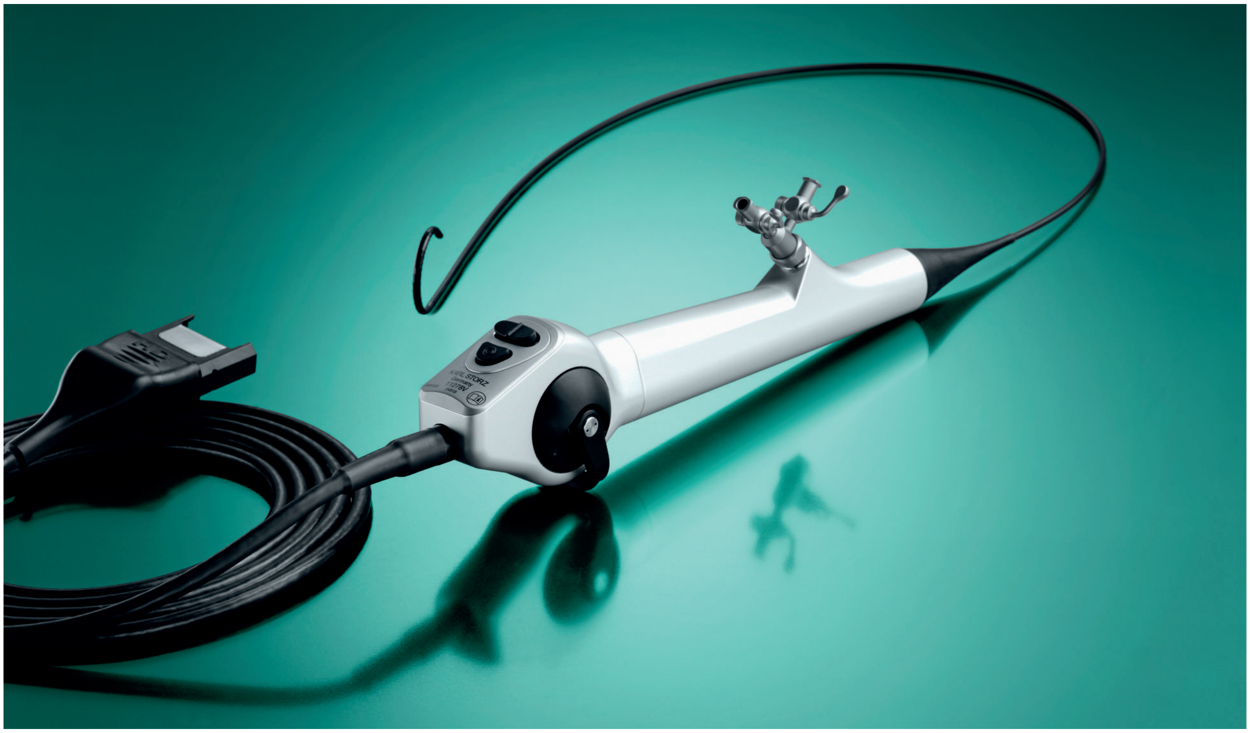

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ROLE OF ANAESTHESIOLOGIST IN THE ENDOSCOPIC URINARY TRACT STONE REMOVAL

6

As compared to traditional open surgery percutaneous nephroscopic operations are indulgent procedures which are performed under local, general or spinal anaesthesia. It is better that a learner starts these procedures under general anaesthesia.

An anaesthesiologist may face different problems while he takes care of the patient. Some of these complications although rarely similar may appear suddenly and even may risk life of the patient. One should be vigilant and the preparations should be made beforehand to cope with such situation.

As far as local anaesthesia[1] is concerned for stone removal, we operated more than 9000 cases under local anaesthesia by infiltrating the route of planned nephroscopy with local anaesthetic agent. Following are the available local anaesthetic agents along with dosage and the analgesic effects.

- Procaine (Novocaine)	3 mg/kg. body weight	30-60	minutes.
- Lidocaine (Xylocaine)	1.5 mg/kg. B. W.	60-120	min.
- Articaine (Ultracaine)	5 mg/kg. B. W.	60-225	min.
- Bupivacaine (Marcaine)	0.75 mg/kg. B. W.	200-350	min.

Toxicity of Bupivacaine should be kept in mind.

0.25-2% solution is used to infiltrate the area. If the concentration is higher the effect will be stronger but the toxic effects of the drugs should be considered.

During local anaesthesia - like other interventions, allergic edema, laryngeal or bronchial spasm or anaphylactic reaction may occur.

Congenital absence of procaine decomposing enzymes or disturbance of liver functions which play significant role in decomposing procaine or by chance local injection into a blood vessel or fast repetition of the medicine may show overdosage symptoms (hypotension, arrhythmia, respiratory paralysis, spasm).

According to literature problems may arise if necessary dissociation of the local anaesthetic agent is prevented by low pH. So it is possible that due to renal acidosis or infection the anaesthetic effect is insufficient. We did not meet such case during our practice.

Combined strong premedication increases the tolerance of the patient. Chlorpromazine 25 mg, dehydrobenzperidol (Droperidol) 2.5 mg, diazepam 10 mg, scopolamine 0.5 mg, midazolam (Dormicum) 10 mg, morphine 10 mg or pethidine (Dolorgon) 100 mg can be used along with 0.5 mg Atropine as premedication for local anaesthesia 40-60 minutes prior to the operation.

Different combinations of medicines may cause respiratory depression along with their sedative, analgesic and antiemetic effects. This is observed specifically when morphine and scopolamine is given together. Significant hypotension is also observed by this combination. The amount of blood lost, mixed with irrigation fluid, darkened with indigo carmine dye can be misjudged in the semidarkness which is required for radiological observation. If hypotension is thought to be due to the side effect of anaesthesia, transfusion or fast decision for open operation may be delayed to a dangerous extent.

Sometimes the patient feels pain in spite of premedication and anaesthesia. Mainly the complaints appear when renal capsule or renal pelvic wall is punctured and dilated. The complaints may also arise when the out of sight stone is being searched endoscopically or the nerve fibres around the renal artery are being stretched. Patient`s tolerance proportionately decreases during operation as the time passes by. Thus some other anaesthesia may also be required when the operation time is prolonged due to a large staghorn stone removal or when an inexperienced surgeon is operating.

In spinal anaesthesia[2], analgesia is required up till the ribs to explore the kidneys. At this level extensive sympatholytic activity and block of suprarenal preganglionic fibres may cause severe hypotension. Hindrance of the movement of intercostal muscles should also be kept in mind. Rising excitement of phrenic nerve due to repeated pricking may provoke hiccough which in turn may precipitate high segments block due to turbulence. We applied it in our few hundred cases of renal stones. It is useful in moderate size stones where the expected time of operation is about one hour. Vital signs monitoring is important in such cases during prone position of the patient while there is a renal support cushion present under the abdomen. In every day practice we use it for ureteric, urinary bladder and urethral stone extraction.

Epidural anaesthesia is securely manageable as compared to spinal anaesthesia. But its preparation time is disproportionately longer as compared to a fast operation itself which may take 5-10 minutes. If injected into a venous plexus or cerebrospinal fluid in the narrow thoracic region, the risk of high spinal block increases. Peripheral respiratory paralysis without dyspnea should also be kept in mind. Even if the cannula is placed in a correct position its tip can perforate through the dura or into the venous plexus due to the movement of the patient (turning of patient into prone position, patient`s position for the operation). Its effect can only be observed after repeated anaesthetic dose which is in the form of circulatory and respiratory disturbances.

Pain in the kidney area can also be reduced by paravertebral block. One should be careful not to puncture the aorta or vena cava. Anaesthetic agent which flows into the blood vessel may cause toxic cardio- respiratory effects.

Resuscitation facilities must be available in the operation theater. Situation of patient is far from ideal during operation. Patient is in prone position under sheets. He is completely surrounded by different types of equipment and tables and there is darkness in the operation theater so the paleness or cyanotic changes cannot be observed. Keen observation can reduce delay in resuscitation.

"Complementary sedation" is applied if regional anaesthesia is insufficient. Inhalation narcosis with mask cannot be used while the patient is lying in prone position. Intravenous narcotic agents {diazepam, flunitrazepam (Rohypnol), midazolam (Dormicum), ketamine (Calypsol), and thiobutobarbitol (Inactin)} may cause apnoea. Such disturbances can be prevented by artificial respiratory methods. Respiration through mask is not reliable in case of patient with overturned face. It may be late to intubate the patient when already the signs of respiratory disturbances have appeared. In such situation life of the patient is in danger so intravenous narcotics are given very carefully.

Safe general anaesthesia[3] can only be assured with intratracheal narcosis. We use it in children, where longer operation time is expected or in patients who require that. Intubation is done on a stretcher near the operation table from where the patient is turned on to the table. Flexible Woodbridge tube is useful in the patients lying in prone position. While turning the patient the punctured vein, position of the tube and relaxed toneless body require equal attention. Decision about the narcotic agent and relaxant is not an easy job for an operation variably lasting from five minutes to two and a half hour depending upon the stone. Time span can expand depending upon the search for the stone and fragment removal after lithotripsy. Sometimes longer operation has to be suspended unexpectedly due to blurring of the field of vision because of bleeding. So the repeated use of short acting anaesthetics is advised.

As far as the muscle relaxants are concerned, 25 minutes efficacy period of gallamine (Flaxedil) prolongs with renal injury. The effect of alcuronium (Alloferin) is lasting longer. Suxamethonium chloride may also be used but not following a non-depolarizing drug like pancuronium bromide (Pavulon) or gallamine.

The patient may be allergic to contrast material which is used intraoperatively to outline the pelvis. Its chance decreases as it is instilled retrograde through the ureteric catheter. Excessive pressure to mark the renal cavity boundaries may cause pyelovascular reflux through the injured blood vessels.

Its late consequence may be the hypersensitivity reaction. The reflux may also cause vascular overfilling, cardiac insufficiency, pulmonary edema and ARDS. Abdominal pressure due to the pillow underneath, inclined chest or the accumulated perirenal fluid may cause respiratory disturbances. Pneumothorax or haemothorax may be the complications of high renal puncture.

Bacterial invasion may also take place through reflux which is characterized by shivering, temperature and diffuse intravascular coagulopathy due to the effects of endotoxin release. In case of bleeding disorders or massive vascular injury urgent transfusion is needed. Explorative laparotomy may also be required in such cases.

Haemodilution, electrolyte disturbance in the blood, hyponatremia or haemolysis may be the after effects of reflux when renal cavity is irrigated with hypotonic solution so the use of isotonic solution is necessary. Cardiac complications may arise due to rise of potassium level due to its retention in the kidney, its release from the blood corpuscles or due to its elevated level under the effect of succinylcholine (Sukolin).

Percutaneous renal stone extraction can be performed under local anaesthesia. It is a simple and indulgent procedure but may have unexpected complications which need special attention, intensive care and regular vascular and respiratory checks. This makes the role of anaesthesiologist important. Strict observation and preparatory measures can save the patient from this situation.

To avoid complications all the patients should be examined thoroughly before endoscopic operations and full attention and harmony is required in the work of operator and anaesthesiologist.

Key points

- All the emergency care equipment should be available in the operation theatre.
- If applicable, local anaesthesia along with complementary sedation is the best way to avoid complications of general anaesthesia.
- Spinal anaesthesia in renal percutaneous surgery can be used in moderate size stones.
- General anaesthesia should be used in children, huge stone bulk and complicated stones or in patients who ask for it.

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TECHNIQUE OF PERCUTANEOUS KIDNEY STONE REMOVAL

7

PREPARATION OF THE PATIENT

Preoperative diagnostics are mentioned in chapter "The Patient".

The day before operation the patient should not take supper, only fluid and medicines can be taken. Enema should be given in the evening and the morning of the operation. If patient needs, sedatives or tranquillizers can be given at night before the operation. It is better to inform the patient that the intervention is an operation and to tell him what is going to happen. If the procedure of the operation is also mentioned to the patient, it is easy for him to understand and it can turn the patient to be co-operative if he is afraid of it. This psychological preparation is especially important if he is going to be operated under local anaesthesia.

We used narcosis in the first eighty patients consecutively. Later on children, heavy or complex stone patients or those who wanted were narcosed but mostly the operations were performed under local anaesthesia.

Plain X-ray is taken before operation and the patient is given cocktail injection (Dolorgon 100 mg, Atropine 0.5 mg, Pipolphen 50 mg) and depending upon the condition of patient Droperidol I/M 1-2ml (2.5-5.0 mg) is given. Atropine 0.5 mg in combination with diazepam 10 mg is being used at our department in Pakistan. The other sedatives may also be given according to necessity.

Cystoscopic examination is performed before the patient is taken to the operation theatre and ureteric catheter is inserted into the kidney or ureter having stone. After removal of cystoscope a Foley catheter is introduced into the bladder and the ureteric catheter is fixed to it with the help of a tape or a knot. Catheter is attached to the urinary bag. The catheter has significance in long operations because overdistension of bladder can be avoided by it and irrigation fluid and urine can pass out. Its other role is that it keeps ureteric catheter in place during mobilization of the patient.

POSITION OF PATIENT ON THE TABLE

The patient lies prone on radiolucent operation table. There are tables available in the market which have inbuilt system for abdominal support that the top is elevated at required place. If such table is not available, washable sponge pillow is put under the abdomen to reduce lordosis. It also helps reducing mobility of the kidney (Fig. 45). On the other hand dorsum of the patient is relatively stretched. This is particularly useful if the approach is intercostal, gap between the ribs increases[1].

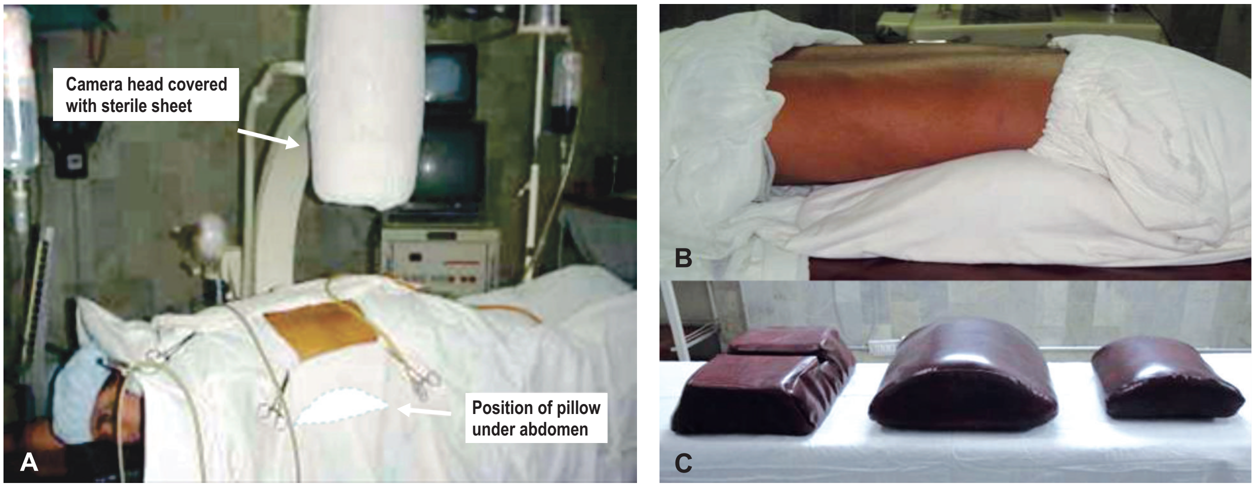
Camera head covered with sterile sheet
Position of pillow under abdomen
A
B
C

Fig. 45 A. Position of the patient during percutaneous surgery B. Support under the abdomen C. Different size of custom made cushions

Some urologists operate the patient in semi-oblique position by elevating only the side to be operated. We do not use big cushion and do not elevate only the side having stone. Reasons to do so are the following.

- If only the side to be operated is lifted more, the hands of the operator are exposed more while puncture and dilation is performed under the X-ray beams.
- If the side is high it is near to X-ray apparatus. There is little space for guidewire and mainly for the guide rod. If the patient is lying in flat prone position, all the dilators can be driven in without hindrance and without touching the X-ray apparatus.
- It is more comfortable for the patient if the pillow is present under whole of abdomen as compared to only one side being elevated.

We use semi-oblique prone position but without renal support pillow in very obese, pregnant[2, 3] or respiratory distress patients (Fig. 11, 12).

There are studies performing percutaneous surgery in supine position[4]. According to those intestinal gas lifts the gut up and there are lesser chances of its injury and stones come out easily due to gravitational effect. This method is not useful in complicated cases or large bulk due to restricted movement of the operator and position of the patient[5]. Recent studies conclude its choice as surgeon-specific[6].

The pillow under the head is set in such a way that the bent arm rests at ease and the patient respires comfortably. Gonads are covered with lead guard. Rolled pillow is slipped under the ankles and urine bag is placed between the legs. Infusion of contrast material with indigo carmine / methylene blue dye is attached to the ureteric catheter.

Camera head of C-arm X-ray image intensifier is covered with a sterile sheet. Stone is properly localized and focused on the monitor by turning it on with the help of foot switch. Patient`s skin is cleaned with disinfectant solution. He is draped in such a way that only small space remains uncovered at the site of operation (Fig. 45).

LOCAL ANAESTHESIA

In case of local anaesthesia long puncture needle is pointed at the shadow of the stone by observing it on the monitor for a moment. By keeping the point of needle on the shadow contrast material is allowed to flow down, drop by drop, into the ureteric catheter which is already inserted into the renal cavity. After a few seconds once again the monitor is turned on. Shadow of the needle is shifted on to the most optimally considered calyx which in most of the cases is the lower one. This exposure should not last for more than three seconds. After that, lower border of 12th rib and its crossing with the needle is palpated. Intracutaneous injection is given 1-2 cm below that point in the line of the needle (Fig. 46). In most of the cases this point falls in the posterior axillary line. This point may vary in some cases e.g., in obese patients or in case of horseshoe kidney[7] where due to malrotation the intervention point is more posteromedial. Other variations may also take place accordingly.

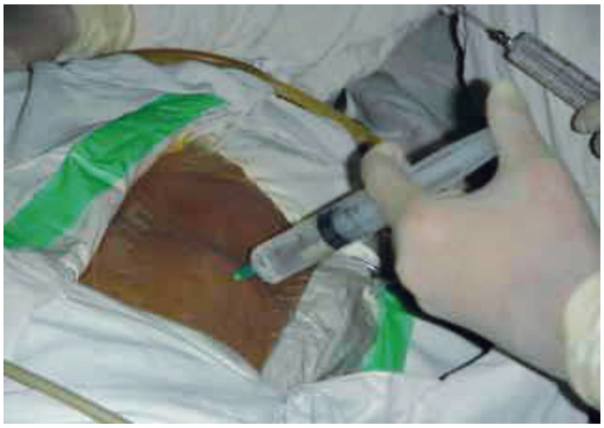

Fig. 46 Local anaesthesia application. A regular needle is used for skin and a long needle till kidney.

Starting from the skin 40-60 ml of anaesthetic agent (0.5% procaine or lidocaine) is injected in different layers till the capsule of the kidney is reached. By that cylinder like anaesthetised area is obtained, through the axle of which puncture and dilation is performed and nephroscope can be passed in without causing pain to the patient.

If the percutaneous operation lasts longer like in case of staghorn stone and the patient becomes restless, intravenous sedatives or neuroleptics can be given to the patient.

NARCOSIS

In case of narcosis the patient lies supine when intubation is performed by the anaesthesiologist. Then he is turned prone. Particular points of issue about narcosis are discussed in the section 'Role of Anaesthesia'.

PUNCTURE

One cm incision is given on the skin where wheel formed after local anaesthesia at the point of needle entry on the skin. Puncture needle is pushed into the kidney. During this action X-ray apparatus is turned on and the needle end is observed as it crosses the capsule. Point of entry into the kidney should be the base of calyx. At this moment it can easily be seen that kidney and the pelvis move by the movement of the needle. But be careful! If gas shadow movement is observed, to and fro with the needle, large intestine is on the point. If due attention is paid colon injury can be avoided.

If the kidney moves while needle is moved and it is directing towards bottom of the calyx, it is pushed further and the puncture will be successful. Stylet of the needle is pulled out. Drops of blue colour show that the pelvic cavity is reached (Fig. 47)

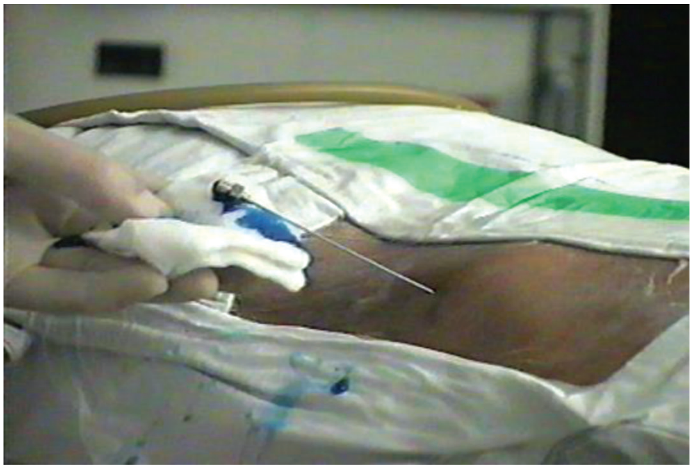
Fig. 47 Drops of blue colour suggest that renal cavity is reached

If the puncture turns out to be unsuccessful, needle is pulled out completely to the skin and depending upon the situation, more or less steeply the puncture is tried once again. If the needle is not pulled out completely and is moved vertically up and down outside, the portion inside the body remains in the original position. It may go into a wrong direction and perhaps bends too. If the needle is felt in a good position in the calyx e.g., bottom of the calyx is pushed inwards at the site of puncture on the screen and fine jolting is felt when the needle punctures through the wall of the calyx but still the fluid does not come out of the needle, guidewire is tried to be inserted in. By viewing on image intensifier monitor, position of guidewire inside the kidney helps deciding if the renal cavity is reached or not. Often it happens that a clot blocks lumen of the needle. If the cavity could not be reached process of renal puncture is started again.

Puncture can also be started by aiming with the help of ultrasound. When the renal cavity is filled and dilated, it can be punctured by ultrasound guidance without difficulty. It is sure that a calyx which is filled well can be seen on the ultrasound picture clearly.

Ultrasound and X-ray can be combined together for the puncture. One plane X-rays and the other perpendicular to it is observed with ultrasound.

If ultrasonically guided puncture does not work, the needle directed under the fluoroscope may be successful. Rotatory movement of the arch of 'C-arm' can also help taking the view of two directions and depth of penetration.

Though different methods of kidney puncture[8] are mentioned now in the literature, we started and adopted a simple technique. Cephalic and caudal movement of pointing needle is controlled by fluoroscope while anteroposterior movement is accommodated initially by pointing the tip relatively towards dorsum of the body and by to and fro movements shifting towards ventrum until the required point of renal entry is reached (Fig. 48).

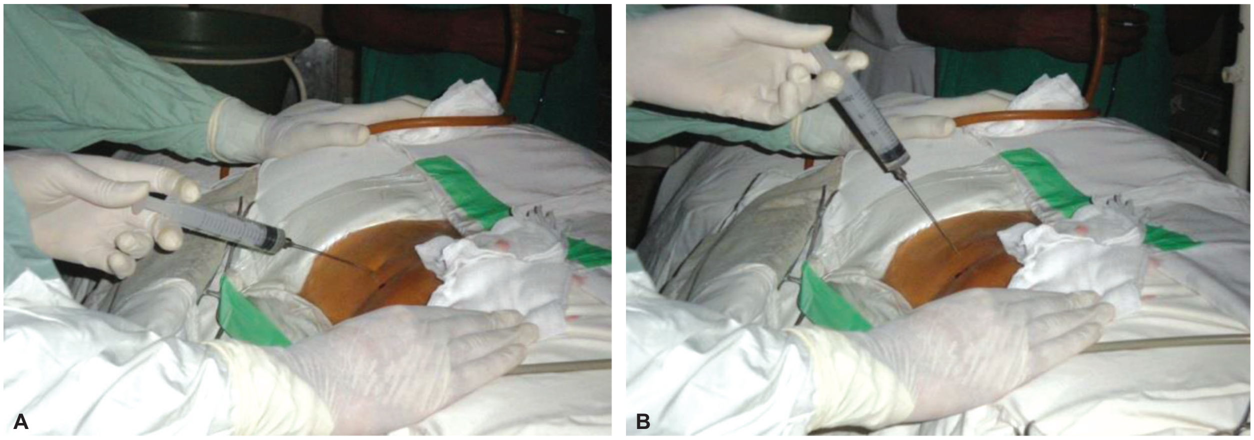

Fig. 48 A. Good start of skin entry – Pointing relatively towards dorsum but aiming at kidney puncture point by viewing on the image intensifier monitor.

B. Not good start of skin entry – Pointing towards relative ventrum of patient

Puncture is the most important phase of the percutaneous operation. Whole of the procedure depends upon it. At this stage keen depth of perception, feeling of inside tissue structures, fine hands and balanced quiescent nervous condition is the utmost requirement for the operator.

If the bottom of a calyx is not punctured exactly and instead the neck is punctured, it becomes very difficult to remove the stone from that calyx itself.

If blood oozes through the puncture needle guidewire is not tried to be inserted in. If we proceed further vascular injury may take place and it may be inevitable to explore the kidney through open operation.

When ureteric catheter cannot be passed up into the pelvis before percutaneous operation, intravenous contrast material is used to lineout renal cavity. With this method the picture of the renal cavity is not so clear due to insufficient distention of pelvis and calyces and the puncture becomes difficult. But after some experience the channel can be made in such cases. Diuresis cannot help in such cases because lesser contrast due to dilution may not lineout the cavity.

Sometimes needle is inside the renal cavity when punctured direct or after IV contrast but is not at required place. It is used to fill the cavity with contrast material and a new puncture is made at an appropriate place.

Puncture direction is also important. For example in case of stone in the upper part of ureter entry through lower calyx is not useful. In such cases upper calyceal groups are punctured through intercostal space so that direction of entry into the ureter is almost straight. Flexible equipment, if available, can be used but it has some disadvantages. Required amount of fluid does not pass through its thin irrigation channels. These are too sensitive, relatively expensive and repair is more costly. Flexible stone grasping forceps which passes through narrow instrument channel wears out earlier.

Scar in case of an already operated kidney stone patient through open intervention should be avoided. In such cases puncture is preferred to be made in between the ribs and the scar and not below it. Puncture through scar may cause needle bending or it can be misdirected due to hard and strong scarry tissue and dilation becomes difficult. After gaining some experience hard internal scar can be pierced by calculated and controlled strong inward movement of the needle or dilators.

One should be vigilant that the force applied during channel making and its dilation through scar should not be so insufficient that one cannot cross the scar or should not be so much that the needle, guidewire or dilators injure the opposite renal pelvic wall or other internal organs. A gauze piece can be used to hold each dilator while pushing it inside. In this way the grip on dilators is strong and operator's fingers are saved from blister injuries.

Stone removal is always easy through a well-planned and properly made percutaneous channel.

Selection of the channel for entry:

Stones to be removed may be present at different sites. The puncture should not be schematic but if possible, in only one discrete direction.

If the stone is present in the renal pelvis the most favourable route is the puncture through the base of lower calyx and dilation through its neck.

This route is also ideal for the lower as well as upper calyx stones (Fig. 49). The same approach is also useful in case of staghorn stones[9] and if required other channels are created through upper or middle calyces[10]. In such a case if the neck of calyx or fornix is punctured instead of its base and a piece of stone flows into the bottom of calyx, it can only be taken out through a new prick.

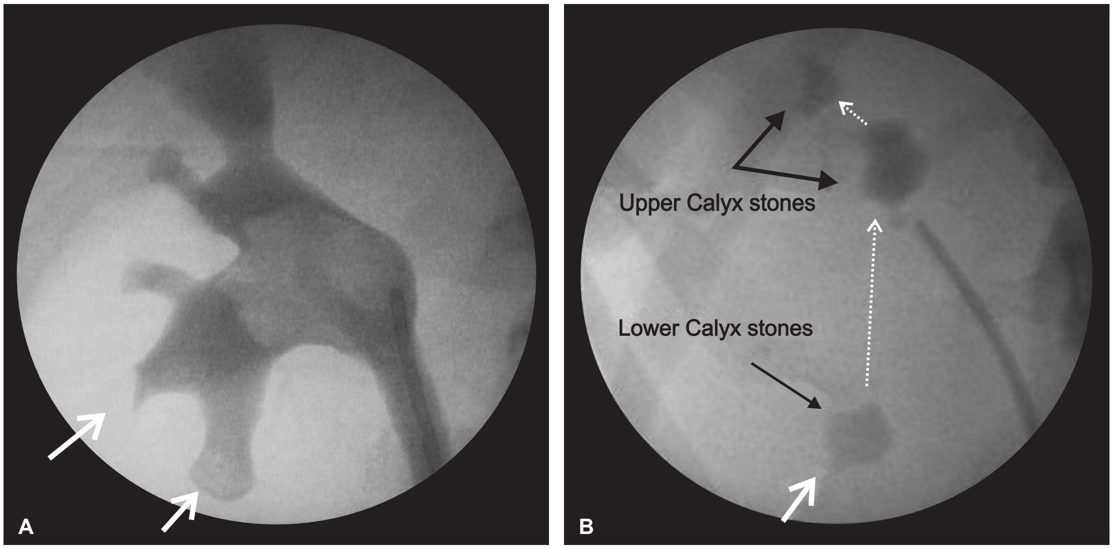

Fig. 49 A. Both the (white arrow) approaches are valid for removal of this pelvic stone. Wide necks will help clearing all the broken fragments.
B. Through the lower calyx all the stones in picture can be removed (White arrows).

In longstanding obstructing stone sometimes renal parenchyma becomes thin at concerned calyx. In such case calyx with healthier parenchyma should be selected if the stone can be approached through that. It is observed that healing of thin parenchyma takes longer time than the healthy parenchymal tissue.

Pelvic and middle calyx stones can be removed by puncturing the middle group of calyces (Fig. 50, 51). Same approach might also be useful in case of large pelvic stones (Fig. 52) which protrude into the upper part of ureter. In such cases puncture is mostly made through 12th intercostal space.

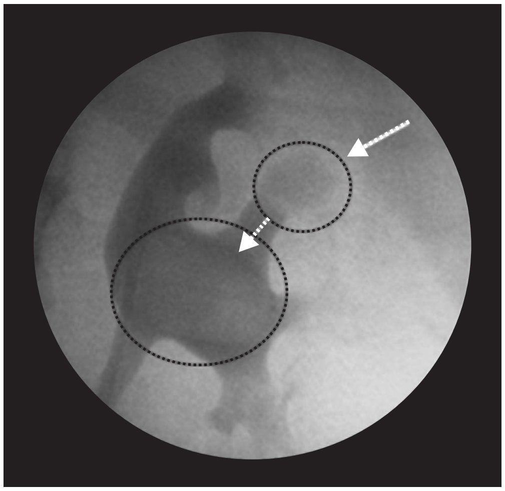

Fig. 50 Point of entry for middle calyx and pelvic stones (White arrows)

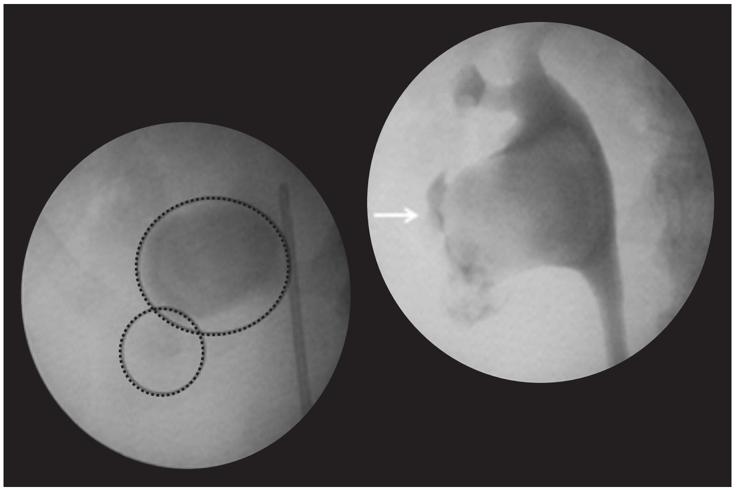

Fig. 51 Middle calyx approach is good for both pelvis and lower calyx stones in this case (White arrow)

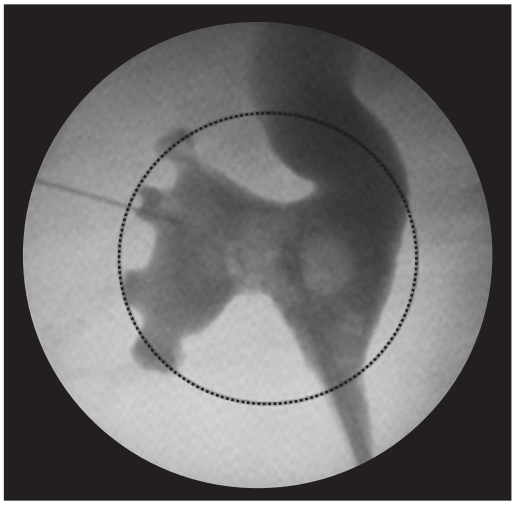

Fig. 52 Mixed type stone extends from pelvis into UPJ. It consists of irregular radiopaque as well as radiolucent portions

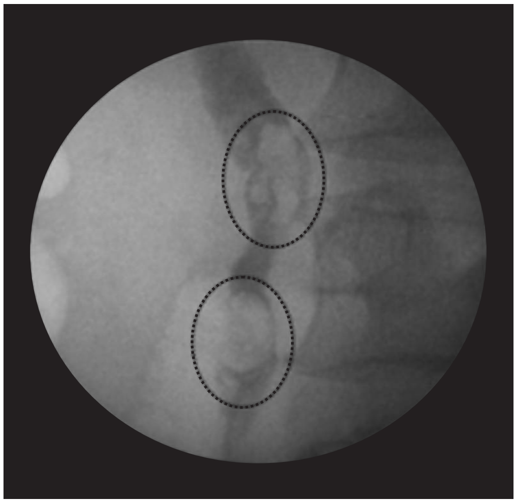

Fig. 53 A. Stones impacted in middle 3rd of ureter.

If the puncture is directed downwards, pleural injury can be avoided. Hazards of intercostal approach may be the restricted movement of nephroscope and its slipping out of kidney due to relative non mobility of the site of puncture as compared to the kidney itself. In the intercostal approach entry should be made along the upper border of 12th rib because intercostal arteries, veins, and nerves run along the lower border of the 11th rib.

In case of impacted stones in the upper or middle part of ureter (Fig. 53) the kidney is punctured through middle or upper calyx. 11th intercostal space can also be used for that purpose but risk of injuring the pleura should be taken into consideration.

The hazard of upper pole puncture is the injury to the neighboring organs (liver, spleen[11], large intestine, pleura). Different complications will be mentioned in a separate chapter.

The scar of open operation may be so hard and tough that the needle cannot pass through it or it bends. In such cases intercostal approach is useful if the stone can be targeted through it.

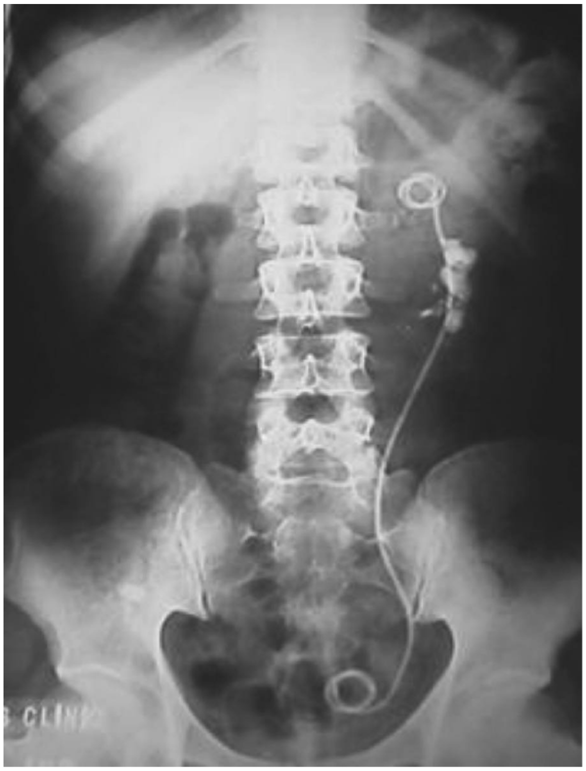

Fig. 53 B. Stones in upper 3rd and a stent. Upper calyx approach is required to reach these stones.

Channel making in staghorn stone cases:

Kidney can be punctured more than once in the same session. For example, stones in the middle and lower calyces can be accessed separately. In most of the cases staghorn stone can be removed by channeling through multiple calyces[12]. In case of a 2nd puncture of a wide neck calyx, pressure through a needle or outer sheath of fascia dilator may be sufficient to drift a small stone from that calyx into pelvis. Otherwise dilation is performed till nephroscope is inserted and stone is taken out.

In case of large bulk of stone a nephrostomy drain is inserted in another calyx while nephroscope or 30F Amplatz sheath is present at initial puncture site. Stones are washed out of sheath after maximum crushing by pressing normal saline into nephrostomy tube with the help of a nozzle syringe.

After developing stone wash technique we started puncturing kidney at multiple places and inserted guidewires in the beginning in complex staghorn or multiple stone cases[13]. We used the channels which were useful during procedure (Fig. 54). At the end of procedure nephrostomy drains were left inside if required. Benefit of an early puncture is that contrast material extravasation into perirenal area during procedure may obscure field on fluoroscope monitor and hinders puncture in later part of operation.

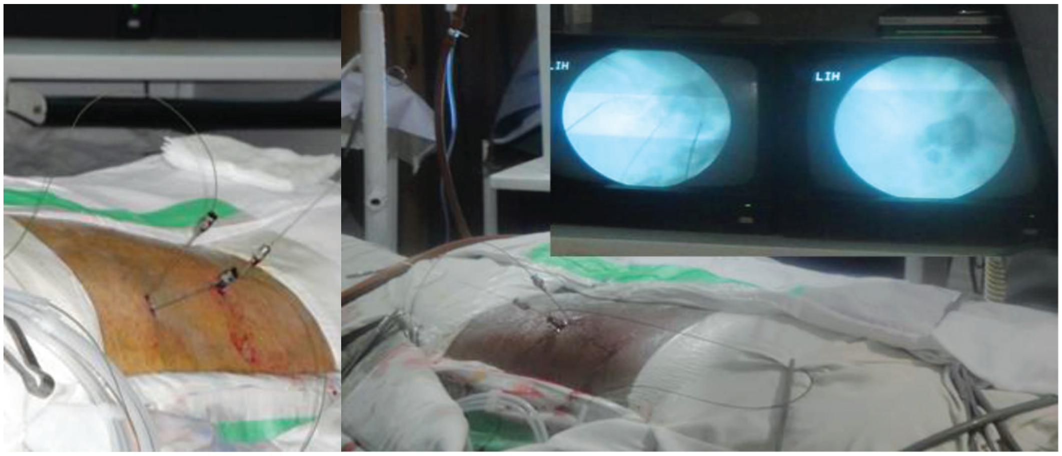

Fig. 54 Three approaches to kidney in the start. Inner view is seen on the monitor.

After removal of stone the operation is finished by inserting nephrostomy drain into one or all of the channels. This drain serves the purpose of haemostasis of wound as well as washing out of clots and debris through a relatively larger outlet than the ureter itself.

GUIDEWIRE INSERTION

When the puncture needle is at a suitable site inside the kidney, guidewire is passed into the puncture needle (Fig. 55). The beginner should insert the flexible end of the wire completely into the renal pelvis passing it by the side of stone. The wire can be inserted only into the calyx having stone after earning some experience. After that the wire is held in position and the needle is taken out. At this moment contrast material flow is stopped. The needle and the guidewire should be straight because a bend of a very small degree in the needle or the wire may hinder the entry of wire. It may happen that the wire has got a minor deflection and it can neither be pushed forward nor pulled out. Even a small kink in the guidewire may cause a friction of a great degree. During the operation flexible end of disposable guidewire may be broken inside the cavity after its multiple use.

A beginner is advised to use two guidewires at a time. This is important because metal dilators or nephroscope may slip out of the renal cavity. In such case the substitute guidewire is used for another intervention.

Two guidewires are inserted as follows; After removing the needle three consecutive Teflon bougies are slipped into the cavity on the already introduced guidewire. The inner most and the middle one is taken out and the outer one is left in place along with guidewire. Now sufficient space is available and the second guidewire is introduced through it. The outer Teflon tube is also taken out. One of the wires is fixed to the sterile sheet covering the patient and the other is used for dilation.

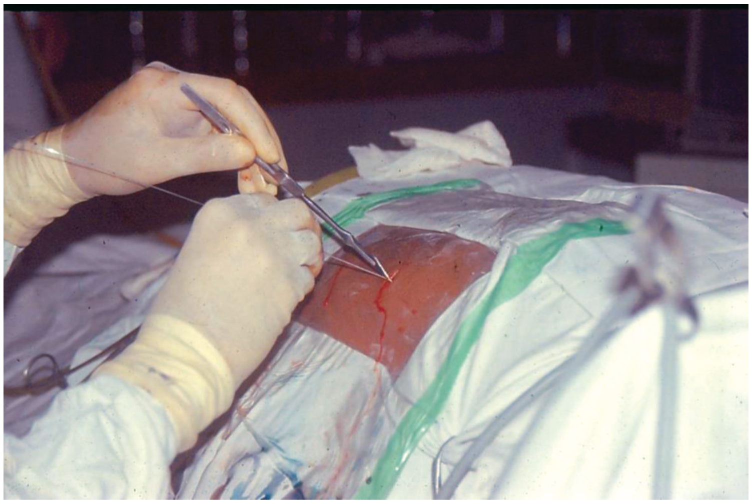

Fig. 55 After insertion of guidewire, needle is removed and the skin is incised for one cm at the point of entry.

If the metal fascia dilators (Fig. 42A)

are used then the sequence to insert two guidewires is as follows; After accurate kidney puncture flexible guidewire is inserted into the needle till required and the needle is taken out. Metal fascia dilators are slipped on the guidewire and the guidewire along with the inner fascia dilator is removed. Then the guide rod is inserted into the outer fascia dilator. Sufficient space is available beside the guide rod for another guidewire which is also slipped in and the fascia dilator is removed. The wire is fixed and the rod is used for further dilation.

DILATION

During the process of routine dilation first comes the set of fascia dilators which has also been mentioned in the previous paragraph. These are used to dilate through the lumbodorsal fascia, the muscles, renal capsule and parenchyma. Under fluoroscope monitoring these may be inserted till the base of calyx and not further to avoid unwanted injury. The contrast material should not flow out and if it happens so, the renal cavity may collapse and dilation becomes difficult. On the other hand extrarenal spillage of contrast material may hinder the view on the monitor. Afterwards comes the 1st telescope metal dilator of the series known as guide rod (Fig. 42B). It is a thin rod, 58 cm long, its lumen just slips over the guidewire and it has a small button like end. It is introduced through the outer fascia dilator into the renal cavity. As soon as it reaches the planned point near stone, fascia dilator as well as the guidewire is removed but the wire may be left inside till maximum dilation. The 2nd one among dilators set is slipped on the rod joltlessly till its button like end. After that all the dilators are slipped upon the other consecutively till the metal dilator of the largest diameter reaches inside the renal cavity (Fig. 42C, 56). These can be observed on the X-ray monitor with instant looks but after gaining experience the observation is not required so frequently because a little jerk is felt when the dilators are passed through. Due to the risk of perforation of the pelvis, rupture, or bleeding these should not be pushed more inside. If the dilation is performed with expert hands, X-ray control is sufficient at the most two times for two seconds each, after every third dilator.

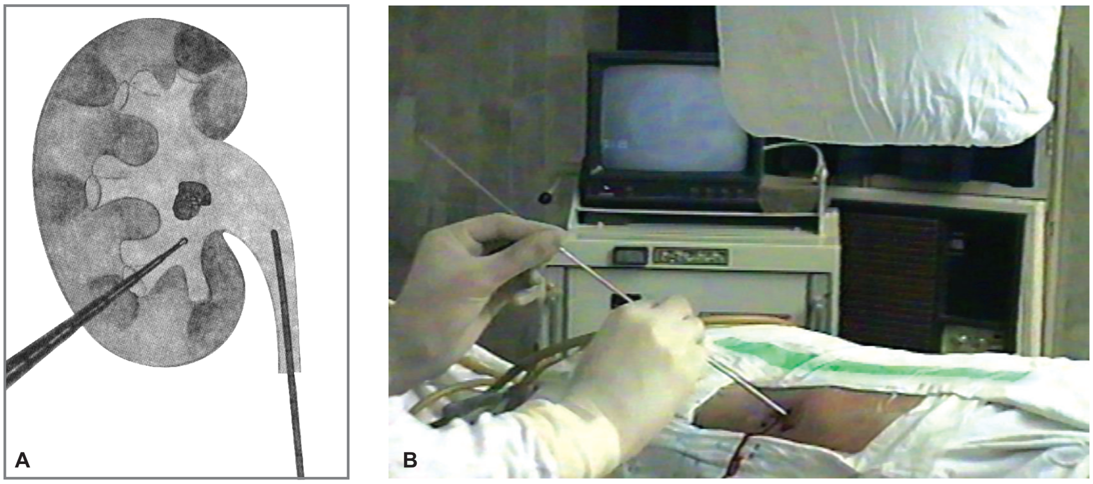

Fig. 56 A. Schematic diagram of all the dilators and the guide rod, one on the other. B. During dilation process metal guide rod is held with one hand while dilators are slipped over one another till the largest diameter is reached.

In the beginning dilator should be introduced slowly, carefully and by rotating it. Later, with experience, the operator develops such fine sense that he needs only some seconds for each dilator to introduce in, and it is absolutely safe manoeuvre too. If the procedure of dilation is slow two metal dilators may stick to each other due to some clot and the inner dilator also moves inwards when the outer dilator is pushed in. This carries the risk of perforation. If outer dilator is tried to be taken out the inner ones may also slip out of renal cavity.

This difficulty can be overcome by lubricating the dilators before-hand and the process of dilation is completed comparatively fast.

If the separation of sticking dilators is not successful, these should be taken out and the guidewire remains inside. These should be thoroughly cleaned with sterile solution and after that lubricating with oil, start dilation again.

NEPHROSCOPY

When the last dilator of the series is also inside the renal cavity, operating sheath of nephroscope is inserted in (Fig. 42D, Fig. 57). From it, which has got inlet and outlet passage for irrigation fluid, dilators and guidewire is taken out (if the guidewire has not been removed in the beginning of dilation). If a beginner is operating, the other wire remains besides the sheath. Situation of the sheath is observed on the X-ray monitor that is satisfying if at the time of removal of dilators whole of contrast material flows out of the external opening of the sheath.

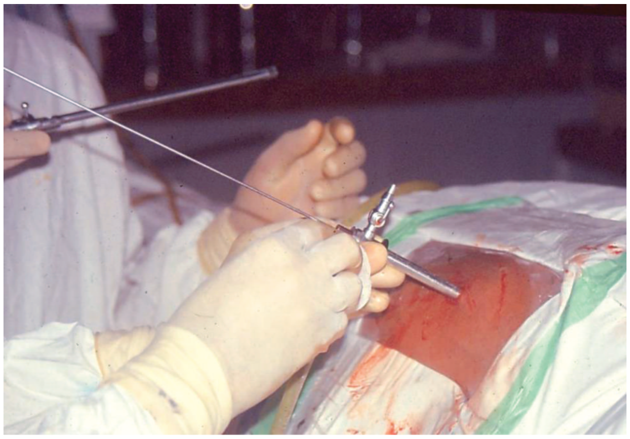

Fig. 57 Nephroscope sheath is inserted over the dilators and long rod is pulled out. All the dilators come out along with rod.

Nephroscope is introduced into the kidney through its sheath (Fig. 42E, Fig. 58). Isotonic solution (normal saline solution) for irrigation is allowed to flow in through the inlet tap. The tap of the instrument channel of the nephroscope should be closed at that time. Field of vision is clear due to this solution which is transparent and colourless. This fluid dilates the renal cavity and on the other hand if the outlet tap is opened, blood clots, internal bleeding and fragments of stone are washed out. Fluid coming out is drained into a container through a rubber tube. Optimal ratio of the fluid going in and coming out should be set precisely.

Fibreoptic cable from light source is attached to the nephroscope. If only dark red field is seen inside on first sight, nephroscope is too much pushed inside and it is lighting up the wall of the pelvis or it is pushed into the parenchyma. With a long stone grasping forceps with closed jaws the wall of the pelvis is tried to be pushed away or the nephroscope is brought outwards a little bit. The inward flow of the fluid starts and field of vision becomes clear. If still not successful, a blood clot is obliterating the field of vision which should be sucked out. If it also does not work, it is advised to disassemble the nephroscope by taking telescope out and clean it because one of the channels for the fluid or the lens may be blocked by the blood clot.

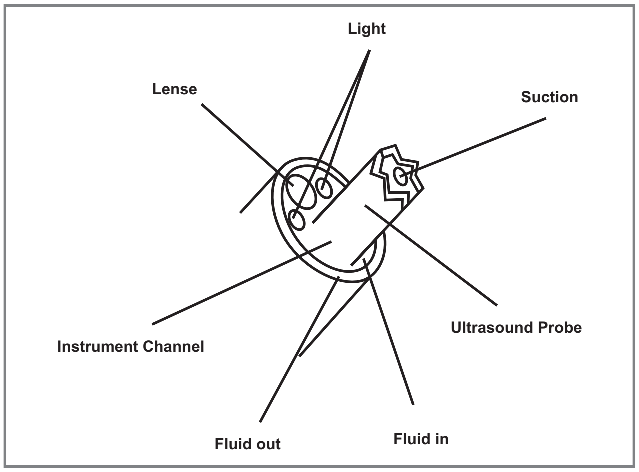

Fig. 58 Schematic diagram of the internal end of nephroscope

In spite of taking care, the nephroscope can slip out of the renal cavity but not from the kidney. At that moment parenchymal tissue may be seen in the form of layers. If it is not taken into notice and inward flow is forced and renal cavity is searched for, it will be dangerous and it may cause damage. These layers can be recognized by fatty tissue, spider-net like connective tissue and by its bleeding tendency (Fig. 69).

In such a case, the instrument can be attempted once again to be introduced into the cavity. Irrigation fluid is stopped. From below through the ureteric catheter contrast material coloured with blue dye is allowed to flow in. Partly, X-ray picture on the monitor and partly through the nephroscope, appearance of blue dye is observed. If the dye is seen through it, its path is followed and the opening is found from which nephroscope slipped out.

Long stone grasping forceps with close jaws or long dilator rod with button-end is introduced through the nephroscope into renal cavity across this opening and nephroscope is guided into the cavity on it. If this manoeuvre is performed carefully, nephroscope once again will be inside the renal cavity. If not successful at all, it is taken out and new puncture and dilation is attempted.

It is necessary for good field of vision that cavity is clean, ratio of in and outgoing fluid is optimal and irrigation fluid should not leak out due to the absence or defect of any of the rubber caps.

Exact amount of fluid going in and coming out is registered during the operation. The fluid coming out is that which collects in the container through outflow tube, in the urine bag and the fluid which flows out otherwise. In case of error there may be a deficit of litres between incoming and outgoing fluid. The fluid may accumulate in the retroperitoneal space and as this is absorbed slowly, it may catch infection. It may lead to pus formation and sepsis. So in and outgoing fluid balance is very important. If the difference is great, fluid accumulation is checked with diagnostic ultrasound and thin polyethylene cannula is put in the retroperitoneal cavity with the help of a puncture needle mostly inguinally. It may be on both sides and the drain may be left in even for 1-2 days. In this way we can cross over the late complications.

STONE OBSERVATION

The stone can be seen in a clear field of vision and under good illumination. Size and as far as possible composition of the stone should be established. While looking through nephroscope it is decided that the stone can be taken out as a whole, or some kind of disintegration is required first.

Whewellite (Calcium Oxalate Monohydrate) stones: (Fig. 65, Fig. 34)

According to international literature generally these are not larger than 1-1.5 cm. In our Pakistani practice we have also seen such staghorn stones. Strongly radiopaque on plain X-ray, dark brown in colour, surface generally plain, sometimes grayish and film-like slightly translucent covering. It can escape from the ultrasound waves and inward fluid pressure can push it to other parts of renal cavity. This stone is set on the opposite wall with ultrasound probe on it with half inward flow in such a way that it does not disappear from the sight. After disintegration the remnants consist of large pieces which can be taken out without leaving a trace. Typically layered and rays like structure may be seen on the surface of split pieces.

Weddellite (Calcium Oxalate Dihydrate) stones: (Fig. 35)

These stones are radiopaque, small spikes all-around sometimes look like porous texture. These may be of different sizes, have loose structure, and large crystals which can be easily seen. These can be easily broken mechanically. In most of the cases light coloured, extraordinarily spiky. Small split pieces consist of collapsing crystals. With ultrasound probe it is just sufficient to touch the stone and it turns into small particles which can be taken out with the help of suction machine.

In most of the cases nucleus of this type of stones consists of whewellite (monohydrate) type. Crystal layer around the nucleus is tried to be broken mechanically. After that the nucleus is taken out as a whole or after disintegrating with ultrasound.

Struvite ($Mg\ NH_4\ PO_4$ hexahydrate) & Carbonate Apatite ($Ca_5\ PO_4\ 3\ OH$) stones: (Fig. 65, Fig. 36)

These are of irregular shapes. In most of the cases they take the form of that part of renal cavity where they are present. These are generally large stones, surface is white or light grayish. Easy to disintegrate with ultrasound probe, these can turn into powder and minute particles can be sucked out.

Staghorn stones mostly consist of this material. On the surface of disintegrated particles fine granular structures can be seen.

Uric Acid stones: (Fig. 65, Fig. 37)

Radiolucent on X-rays, these are light and dark yellow or reddish coloured stones with plain surface. Their shape ranges from round ball to most irregular cast type. Size may be a very small ball or it may be a large staghorn stone completely filling the renal cavity. Even ultrasound or pneumatic disintegration may be difficult. On breaking annual rings like structure can be seen on the pieces.

Cystine stones: (Fig. 38)

These are rare stones, relatively radiolucent on X-rays due to their sulphur content. Colour reminds of wax and these have almost bright smooth surface. Small ones can easily move away. Due to the solid consistency large stones are hard to break.

Brushite stones ($CaPO_4$):

These are phosphate stones of acidic urine. Ivory colour and so hard that disintegration is difficult. On the surface of its particles, among its layers, column like formations can be seen.

More the calcium content of the stone, more clearly visible the stone is on image intensifier monitor. Too much time and energy should not be spent on the endoscopic analysis of stones. Exact analysis is performed after the stone removal which takes place as metaphylaxis.

STONE REMOVAL

Stone of any type, size and composition can be disintegrated and removed percutaneously. It is not advisable to perform open operation[14] for stone extraction in the age of percutaneous[15] and extracorporeal techniques[16] particularly in case of repeatedly operated solitary kidney.

Small stones can be found easily in dilated pelvis of kidney. To remove the stone as a whole which can be established by looking at the preoperative X-rays, a nephroscope can be used which has incorporated triradiate forceps. With this Wickham-Miller type nephroscope, in simple cases, operation can be completed within 3-5 minutes from incision to the skin suture. Surely a simple nephroscope and a triradiate forceps can also be used for the same purpose (Fig. 59).

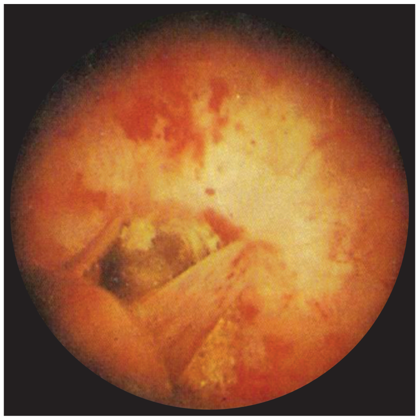
Fig. 59 Small stone held in forceps and taken out.

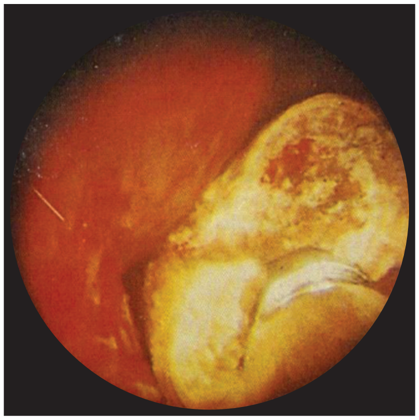
Fig. 60 Ultrasound probe rests on the stone.

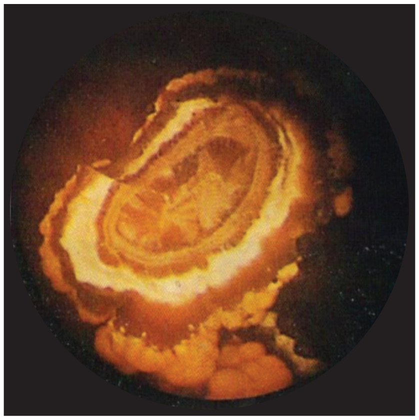
Fig. 61 Fragment of broken stone. Note the layered structure. This stone consists of Whewellite, Struvite and Uric acid layers.

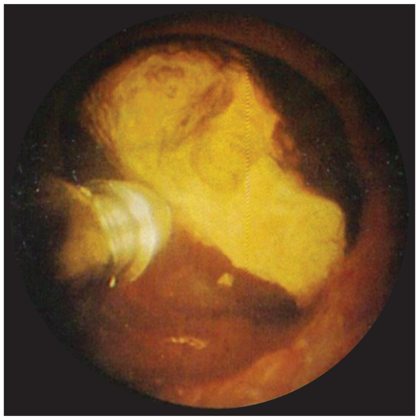
Fig. 62 Ultrasound burr made a groove on hard Uric acid stone

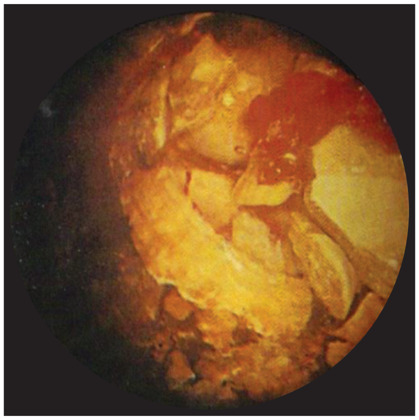
Fig. 63 Stone particles after disintegration inside the renal pelvis

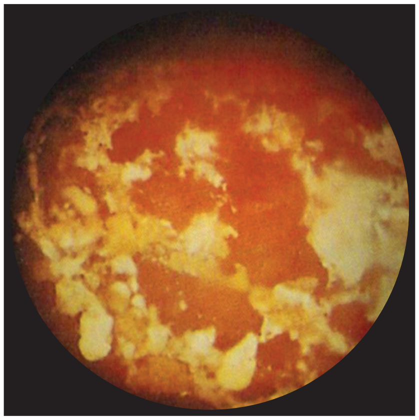
Fig. 64 Minute particles of Weddellite (Calcium oxalate dihydrate) after crushing

It can be decided by observing the stone that it can be removed as a whole or disintegration is required. This can be judged by its look and shape.

The stones larger than 8 mm cannot be taken out through the operating sheath of the nephroscope. After some experience, it can be known by just looking at them. Even the size is mistaken when the stone is tried to be taken out and it does not get into the sheath. At this moment it is not forced to be taken out. Stones of one cm diameter can be removed through Amplatz sheath.

If the stone is a bit larger than one cm and seems to be soft, mechanical stone crusher or fine triradiate stone grasping forceps (Fig. 43E) is used to crush it into pieces which are removed simultaneously. When the stone is caught, the forceps is always rotated around its own axis before its extraction to exclude the possibility of catching pelvic mucous membrane along with the stone.

Large (struvite, carbonate-apatite) or hard stones (whewellite, uric acid) are crushed ultrasonically or by other means (Fig. 60 - 64). Ultrasound probe is inserted through the instrument channel of nephroscope to the surface of stone. With a very slight pressure it is supported with the opposite wall of the renal cavity so that it does not move at the time of disintegration. With the help of foot switch the ultrasound generator and suction system is controlled which work simultaneously.

Time of ultrasound disintegration depends upon the hardness of stone. Soft stone turns into powder like pieces within seconds which is sucked out and it can be seen at the bottom of the bottle where ultrasonic suction fluid accumulates. Stone analysis can be performed from these pieces.

Special attention is required when weddellite stone is crushed with ultrasound. As soon as ultrasonic disintegration is started, this stone turns into powder.

After the removal of weddellite shell if whewellite nucleus is also present, it can be taken out as such.

Ultrasonic disintegration along with suction has a great role in staghorn infection stone. In many cases, struvite and carbonate-apatite stones can almost be broken down turning into powder and sucked out from the pelvis and calyces (Fig. 65).

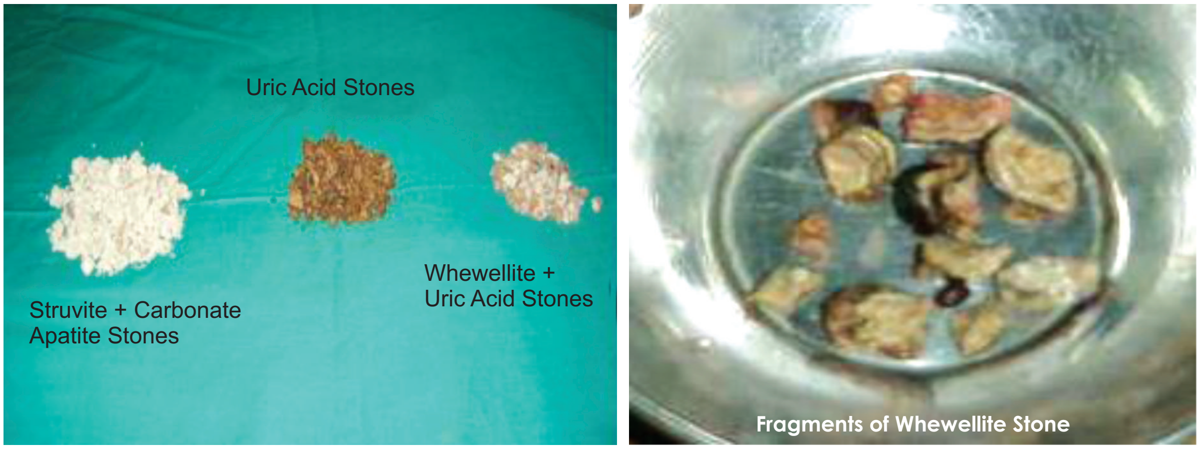
Uric Acid Stones
Struvite + Carbonate Apatite Stones
Whewellite + Uric Acid Stones
Fragments of Whewellite Stone

Fig. 65 Different types of stones

In case of staghorn stone filling whole of the cavity[17], two or three sessions are required for disintegration and extraction though the time of operation and number of sessions have been reduced by inducing stone wash technique. Uric acid stones, if small, oral dissolution is tried. This consistency staghorn stones are rare in Hungary while those are frequently seen in Pakistan, mostly mixed with Calcium. In such cases the stone cannot be turned into powder. Uric acid stone with anhydrous crystals is very hard and disintegration may take longer time. The fragments are taken out with stone grasping forceps after breaking with ultrasonic or pneumatic lithotripsy.

In whewellite, brushite and uric acid staghorn stones disintegration may take long time. Weddellite, struvite and carbonate-apatite stones need seconds to break but their larger size may also take longer time.

In our experience, in case of hard and smooth surface round stone, ultrasonic lithotripsy is preferable on pneumatic lithotripsy to start with disintegration. Its suction mechanism restricts stone to drift away. With ultrasonic probe a niche or groove is formed on stone, equating the shape of the ultrasonic probe tip thus stone does not move away (Fig. 62).

In case of ultrasonic lithotripsy, in principle, ultrasound waves do not injure the soft tissue. Soft parts absorb the longitudinal waves which pass through without causing disturbance and injury. These are diverted back only from hard surface. At this moment they exert their force for disintegration. In practice these waves can cause damage indirectly to the wall of pelvis and calyx through the stone which is resting on it. The stone movement by high frequency of ultrasound can cause injury to urothelium. As a consequence pyelorenal reflux may occur leading to infection. Risk of infection is also there when infected stone particles cross the injured wall into the parenchyma. So, in case of staghorn stone or when the patient has infected urine, preoperatively antibiotic therapy is given till the infection disappears or it is administered at least for one week before operation. During operation diuresis is applied with the help of infusions and diuretics. Postoperatively the antibiotics and diuretics are also given.

During percutaneous operation damage to internal lens of telescope may be caused if ultrasound probe gets near to it. It should always be at some distance. It is seen in general that the nephroscope wears out earlier if ultrasonic lithotripsy is used as compared to pneumatic lithotripter. This may happen due to high temperature of ultrasonic probe.

Improvement of electrohydraulic stone disintegrator is also in process. This can injure soft tissues easily. Use is also a bit complicated because it is not incorporated with suction mechanism so removal of stone debris is an extra issue. Its advantage is that it can be driven into the ureter due to probe flexibility and an impacted stone can be broken. Furthermore it is more useful among stones in large cavity e.g., in urinary bladder because support of opposite wall is not required.

If some stone particle is drifted away, it should be "chased after". If we leave it inside, it may cause trouble to the patient or it may enlarge with the passage of time and later another operation is required. This is particularly true in case of infection stone.

Electrohydraulic and ultrasound technique can be combined together. Very large and hard stones can be broken down electrohydraulically and then the small pieces can further be disintegrated with ultrasound. Same is true with pneumatic and ultrasonic disintegration.

Some practical advice for ultrasound stone disintegration

A moderate size stone should not be disintegrated to the end at the same time. One or two small pieces are broken and removed at one time. Larger piece of stone helps hindering the sweeping away of smaller pieces.

A beginner should start with small stones in the dilated pelvis of a kidney which has wide lower calyx. After gaining experience he can proceed further. Sometimes, along with a stone in the lower calyx or renal pelvis there is another small stone e.g., in the middle calyx which cannot be reached through this entry. Before starting to make another channel, this stone is tried to be pushed from outside with a long needle inserted into that calyx. If the neck of this calyx is not narrow, the stone is pushed with the needle or some isotonic saline solution is pushed into the calyx which may drift it out into the pelvis and it can easily be removed from there with the help of nephroscope which has already been inserted through the lower calyx.

Sometimes pelvic perforation takes place during the procedure but the operation should not be stopped. The stone is removed and nephrostomy drain is placed in. Wound heals spontaneously without complications and open operation is not needed. Size of this wound is not more than the distance between two sutures in pyelotomy operation performed by traditional open way.

Too much irrigation fluid should not go out of renal cavity after its perforation and the stone should be taken out as soon as possible. If large quantity of fluid flows into the perirenal cavity, it may cause complications.

The stone can slip into perirenal tissue through perforation. If it cannot be taken out easily, it is better to leave it there. If there is no complication due to possible infection, it can be left there. It will be harmless for whole of the patient`s life. But it is important to mention it on the discharge slip. Such situation may also turn up that the stone is caught and it is tried to be taken out along with the nephroscope itself. It succeeds to some extent but it is missed outside the renal parenchyma, in the fatty layer or muscles or in the lumbodorsal fascia. In such case it is better not to proceed with the same instrument. Randall type stone grasping forceps and if it is not available, alligator forceps is used at this moment. With the help of X-ray image intensifier it is easier to take out the stone with this type of forceps.

Stone in the narrow stemmed calyx or in the diverticulum is discussed separately.

Bilateral stones can also be operated simultaneously[18, 19]. We start with the kidney having smaller size stone[20]. If the procedure went smooth and the patient is stable, other side is started.

Removal of stones impacted high in the ureter is also performed percutaneously through the kidney. We have also expanded it to the stones in the middle part of ureter. Its technique will also be mentioned in later part of this book.

Percutaneous stone extraction is still performed at some departments in two steps while the others finish it in single step. In the first case, puncture and dilation is the first intervention. Drain is left inside. After some days stone is removed with the help of nephroscope and again a drain is inserted postoperatively. At some places radiologist performs first part of the operation and the urologist the other part. For the period in between, the patient may be allowed to go home or the stone is removed by urologist after radiologist finished his job.

Now-a-days, in most of the cases, puncture and dilation is performed and the stone is removed at the same time. In case of small stones even nephrostomy drain is not left inside.

The patient may be discharged after two days. Now, after developing the techniques, patients with staghorn stones are rarely operated in more sessions by us. If so, most of them are operated in two sessions and seldom in three sessions. Multiple sessions are mostly performed in very complicated and solitary kidney patients. The patient is informed beforehand.

Ultrasound pounding and complete removal of staghorn stones filling the cavity need synchronized harmonic movement of four or six skilled and sensitive hands (operator, assistant and/or theatre nurse). Work during the operation consists of taking care of taps for in and outgoing fluid, tap of instrument channel and insertion of forceps through this channel or its changing with ultrasound probe. It also includes the stabilization of nephroscope operating sheath and taking out and slipping in of inner shaft. Holding of stone and releasing it after it is taken out, repetition of the same procedure for many times, and the use of footswitch for ultrasound or pneumatic system and X-ray monitor is also part of their work. Contrast material and change of the bottles of irrigation fluid is also taken into account including improvisation in all these procedures.

What to do after stone extraction?

As the stone and all its particles are removed, renal cavity is observed with the help of X-ray image intensifier and the parts of kidney are seen with nephroscope which are in approach. This is done to check that any fragment of stone or blood clot is not left inside. If such thing is found, it should be taken out. Very small particles like the size of head of common pin are not bothered about. These come out through nephrostomy drain or natural route. In many cases on a part of papilla, sub-epithelial plaques (Fig. 66) may be seen which might have significance in future (metaphylaxis, management).

In some cases tumour is discovered during operation which was not observed on pre-operative X-ray film. In such cases biopsy is also taken.

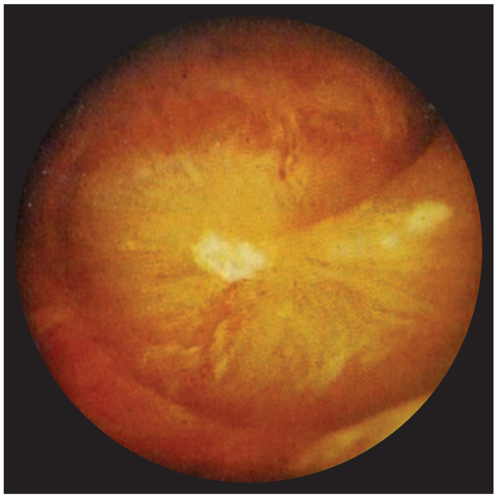

Fig. 66 Renal papilla with subepithelial plaque

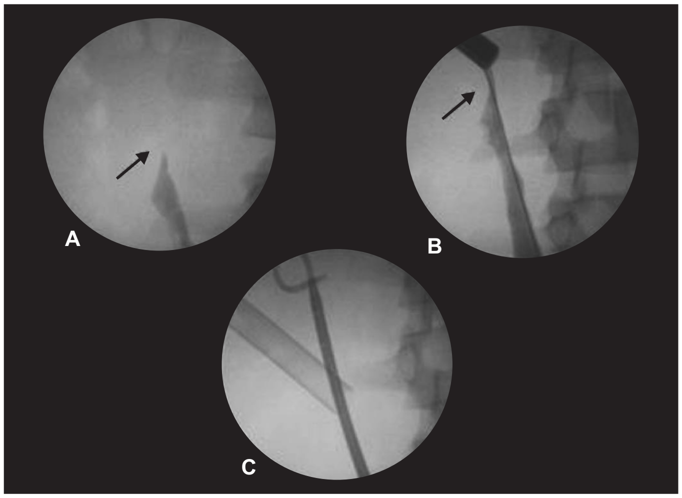

Fig. 67 A. Post-pyelolithotomy stenosis on retrograde urography
B. Guidewire through stenosis. Then UPJ incised
C. Splinting with endopyelotomy stent

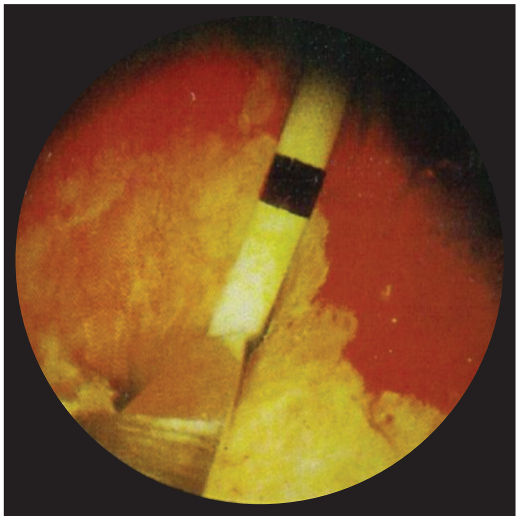

Fig. 68 Endopyelotomy knife pointing postero-laterally. In severe stenosis cases it is incised while two guidewires are inside

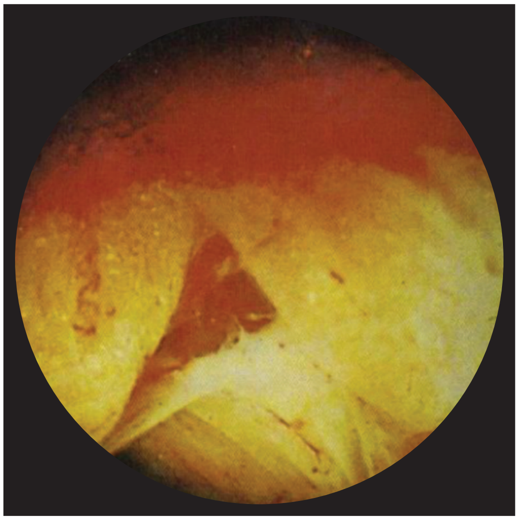

Fig. 69 Endoscopic picture showing parenchymal connective tissue and perinephric fat when the nephroscope slips out of renal cavity

Stricture of ureteropelvic junction may be provoking cause of stone formation. For that reason obstruction in the urinary flow is tried to be eliminated. The stricture can fairly be seen through endoscope. It can be incised and splinted endoscopically (endopyelotomy) (Fig. 67, Fig. 68). It will be discussed in later part of this book.

Nephroscope can also slip out of kidney during manipulation (Fig. 69). If the substitute guidewire had already been inserted, it can be used for re-entry starting from dilating again on the wire. Otherwise contrast material along with blue dye is pushed through already inserted retrograde ureteric catheter. Partly by observing on the monitor and partly through nephroscope blue colour flow out of kidney is traced. Long guide rod or a flexible guidewire through a ureteric catheter is introduced into the nephroscope and guided into the place from where blue dye is coming out. In most of the cases passage is retraced, otherwise a new channel is created.

As mentioned in the section 'The Stone', sometimes foreign body may become a cause of stone formation. Suture material that caused stone formation, stones over a suturing thread in urinary bladder and stones over broken DJ stents are shown in Fig. 70. Cause of stone formation should also be removed.

As soon as the cavity is empty and clean, in and outgoing fluid taps are closed. Nephroscope telescope is taken out. 20F nephrostomy drain is inserted through the outer shaft into the pelvis, if possible to the upper calyx through the operating sheath of nephroscope if the entry is through lower calyx. Aim is to keep sufficient length of drain inside the renal cavity so that it does not slip out during movements postoperatively. Side hole is made on the internal end of drain which can help coming out of small crystals and blood clots.

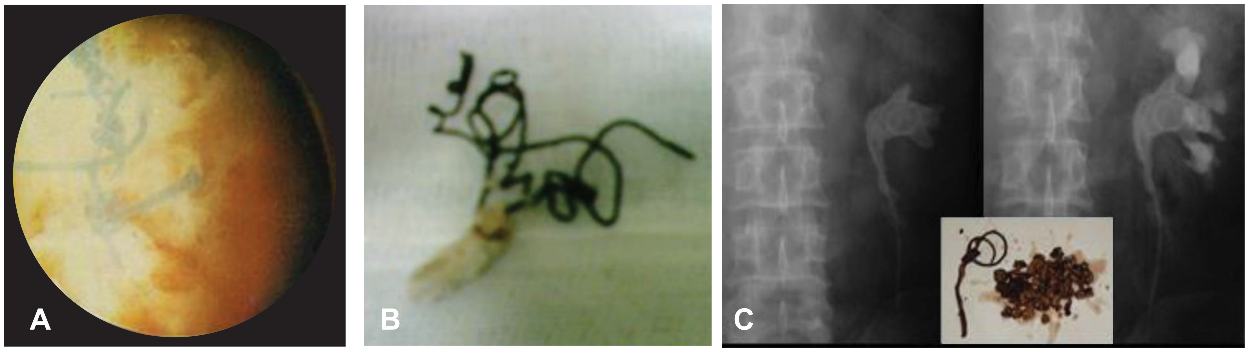

Fig. 70 A. Previous pyelolithotomy suture in the renal pelvic wall that became the focus of stone Formation.

B. Urinary bladder suture material along with a broken part of stone. Actual size of stone was large.

C. Stone on a broken DJ stent. Plain film, IVU showing renal function and removed stone and stent,

Contrast material is injected into the renal cavity through nephrostomy drain and it is observed on the fluoroscope monitor. Remaining particles of stone, extravasation showing pelvic wall injury and ureter occlusion can be excluded by this way. If everything seems to be in order operating sheath of nephroscope is taken out by leaving the drain inside. Nephrostomy drain should not press or stretch the pelvic wall because it may cause postoperative nausea, vomiting or malaise.

The drain is fixed to the skin and generally taken out after 24 hours. It may remain inside for longer period if required.

Nephrostomy drain is not inserted in uncomplicated cases, i.e., when there is no bleeding, or the stone is taken out as such or it is broken and all the pieces are removed. Series of tubeless PCNL by different authors can be seen in the literature. Benefit of keeping the drain inside from few hours to a day or two is clearance of clots and debris which if remain inside may cause ureteric occlusion causing delayed recovery.

When there are many minute particles and remaining small fragments to be removed, two nephrostomy drains are inserted. This is the same as for large bulk or staghorn stones necessitating double or multiple channels for its removal. Drains are inserted into different calyces (Fig. 71).

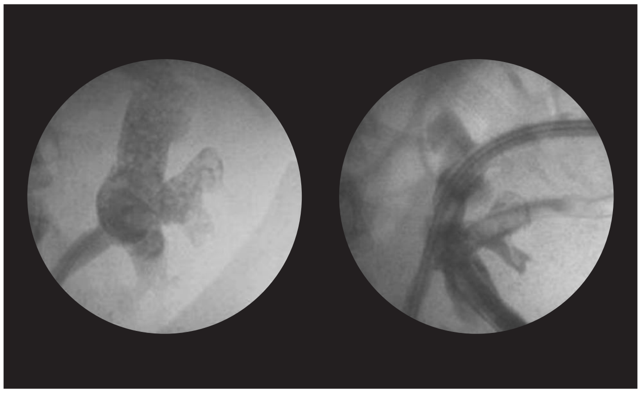

Fig. 71 After removal of complex multiple stones drains are present in all three calyceal groups

The wound is dressed around the drain and it is connected to the urine bag. 10-20 ml saline is injected into the ureteric catheter while it is pulled out. It will wash tiny stone particles and blood clots from the ureter through pelvis into the drain. As soon as plain saline is seen in the drain, ureteric catheter is removed and balloon catheter is taken out of bladder. If the patient is sedated, Foley catheter remains inside till he is completely conscious. If blood or massively blood stained urine comes out of drain, do not fall into panic. Kidney region should be compressed from outside with two hands. If bleeding does not decrease, drain is closed for some minutes. Blood clot will itself stop bleeding and later this clot comes out of nephrostomy drain. Exposure operation is occasionally necessary in case of massive uncontrollable bleeding. Among our +20,000 interventions seven cases had to be opened due to severe bleeding.

The patient after cleaning is turned on his back to a stretcher which is brought beside the table. For another such stone problem if it recurred, most of our patients preferred such intervention.

POSTOPERATIVE PERIOD

The most important is to maintain the record of patient. Pulse and blood pressure should be written on the bedside chart. ESR level should be determined when necessary. Diuresis, functioning of drain and postoperative bleeding is checked. If bleeding was massive during operation, pulse and blood pressure should be monitored at 5-10 minutes intervals.

Advantages of diuresis enhancement

1. Increase of orthograde urine flow against possible pelvirenal reflux due to operation and decrease of possibility of pyelonephritis.
2. It hinders blood coagulation and helps clots to wash out.
3. Renal parenchyma becomes swollen, operated channel is compressed and injured vessels are also compressed. It has haemostasis effect and accelerates the adherence of the wall of the channel.

The patient lies in his bed on the day of operation. He is allowed to take fluids, can sit up and move if possible in his bed or in some cases out of bed.

On the second day of operation the patient is allowed to get out of his bed and can walk around. Now plain X-ray picture is made. Antegrade contrast filling examination is performed and nephrostomy drain can be removed. After removal of staghorn stone until the urine is totally clear dissolvent irrigation depending upon the chemical composition of stone may be applied continuously into the cavity through the drain. Solution for chemolitholysis[21] is administered in through 10F cannula and 8F is used for its outgoing. In case of already present two drains one drain can be used for inflow and the other for outflow. Hemiacidrin solution is used for struvite and carbonate apatite stones forming in an infected organ. In case of pyonephrosis we successfully used 0.1% Pyodine solution to clear the cavity. In case of uric acid stones irrigation is performed with tris-buffer (Liotris) for 5-7 days. Nephrostomy drain is left inside if residual stone particles are found on the postoperative film in the renal cavity. One should be vigilant in case of translucent uric acid stones. Ultrasonic examination may be necessary. Through the same channel (without new puncture and dilation) these particles are removed with nephroscope and grasping forceps. Cause of residual particles may be that they flow into other parts of cavity, they get wrapped in a clot or sometimes work is to be finished in hurry due massive bleeding. In many cases residual stones cannot be observed on the fluoroscope monitor immediately after operation and these are discovered only on the second day of operation. If large enough that those cannot drain out with flow of urine or uneven having spikes, those should be removed.

> While having postoperative ultrasound examination inform concerned department about the presence of drains and DJ stent, if inserted. Without this knowledge these foreign bodies in kidney may be confused with stone.

DRAIN REMOVAL

Nephrostomy drain closure trial is given before its removal. Drain is blocked for about two hours. Patient is asked to move around. There should be no pain or heaviness on the side of operation. Drain is opened and checked to see if fluid comes out with pressure or there is regular dribbling. That drain closure could be done even at completion of simple stone extraction at the operation table.

In the earlier phase we used to remove the drain completely. Many patients complained of soaking with urine coming from the side. Some others were uncomfortable with being wet with urine using pads or different methods to protect them.

We modified the method of its removal. After opening the knot, the drain was taken out of kidney with slow rotatory movements and left under the skin. It was taken out when completely dry. This manoeuvre was not found helpful in very lean patients or children.

Details of patients, operation and data related to stone is collected groupwise and can be used for research work.

It is important to collect pre and postoperative X-ray films and stone analysis report. It is necessary in metaphylaxis and for further management of the stone patients.

Advantages of percutaneous stone extraction as compared to open operation:

1. Renal cavity injury and trauma is minimal.
2. It can be performed under local anaesthesia in most of the cases, avoiding the complications of general anaesthesia.
3. Stone can be broken in the renal cavity and the cavity can be completely cleared under visual control.
4. Technical difficulties do not appear during the operation e. g., renal mobilization in a repeated pyelolithotomy.
5. No disfigurement of the body and distorting scar can be avoided which in many cases hinders the movement.
6. Very thin scar formation on the parenchyma of the kidney.
7. Postoperative wound problems are simplified. Incision of about one centimeter size heals soon, its mark hardly remains and infection is not expected.
8. Postoperative period is very short. On the second day of operation patients can walk around without difficulty. They can be discharged within 3-5 days.
9. The patient can resume his job very early as compared to open operation where it is 6-8 weeks. Those who are not physical workers can start working even earlier.
10. If it is unsuccessful, the intervention can be repeated for more times. Even open operation can be performed easily if required.
11. There is no chance of recurrence of stone due to foreign body like suturing material which is used to stitch the pelvic cavity.
12. Time span of operations - except some particular cases is smaller as compared to traditional exposure operation. It is not rare to complete the operation even within minutes. Even if it takes longer time, it is always less troublesome for the patient.
13. Incisional hernia like late postoperative complications can be avoided.

Disadvantages:

1. Special and expensive equipment is required.
2. X-ray load may be high, particularly when an inexperienced surgeon operates.

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ENDOPYELOTOMY

8

Ureteropelvic junction (UPJ) stenosis that may be congenital or acquired, can be treated with different techniques applied through retrograde, percutaneous, laparoscopic or open operation. Endopyelotomy[1] is a novel percutaneous procedure to overcome a stenosis of <1.5 cm. Youngest of the patient with us was four years old. A patient having a long stenosis (Fig. 72) or complete stenosis (Fig. 73) is not suitable for endopyelotomy[2]. Retrograde open end ureteric catheter is inserted on a guidewire in the same way as for percutaneous nephrolithotomy. Though the stenosis had already been assessed on IVU examination, retrograde urography is also performed to finally ascertain the stenosis and its length.

We perform this operation[3] mostly under local anaesthesia and complementary sedation. Usually percutaneous approach is made through middle calyx or sometimes upper calyx. Aim of such renal entry is that UPJ should be visible while operating upon.

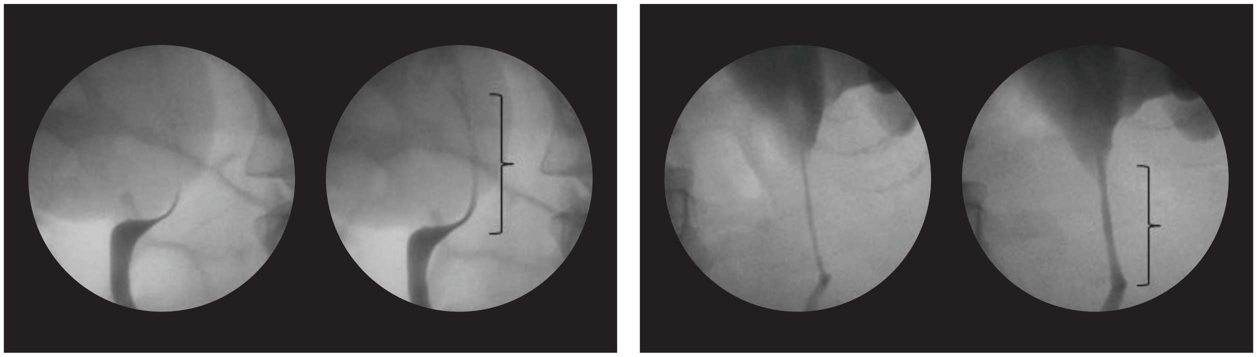

Fig. 72 A. On retrograde examination long narrow segment could only be outlined properly after pressure filling.

B. Even after retrograde pressure filling narrow segment could not show elasticity of the upper ureter

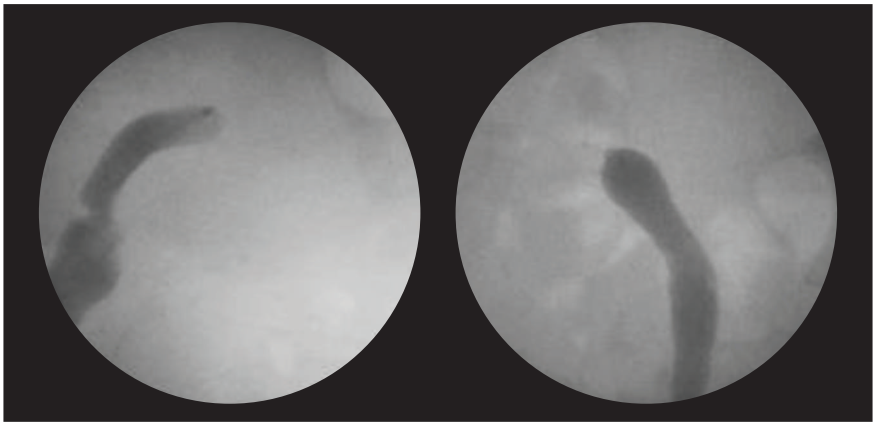

Fig. 73 Completely obstructed ureter is not worth performing EPT

An open end ureteric catheter along with flexible guidewire is placed retrograde prior to operation. After percutaneous dilation of the track, nephroscope is introduced into the kidney and ureteropelvic junction is observed. If an associated renal stone is present, it should be removed first.

If stenosis permits, endoknife is introduced in to incise the UPJ along the ureteric catheter (Fig. 44). Otherwise a second guidewire is inserted antegrade beside the ureteric catheter and retrograde ureteric catheter is pulled down below stenosis while lower guidewire remains inside the kidney and then endoknife is used. Ureteric catheter should not be taken out until the antegrade inserted guidewire crosses the UPJ.

In **severe stenosis** cases antegrade guidewire does not cross UPJ beside the ureteric catheter. This mostly happens in already operated kidney. Ureteric catheter internal end is pulled up and out through nephroscope. Already inserted guidewire into the ureteric catheter is removed from below and an antegrade guidewire is introduced into it until it crosses the stenosed part. Ureteric catheter is pulled down but not completely out. 2nd guidewire is inserted along the first guidewire pushing it down to urinary bladder. Ureteric catheter is removed and the 1st inserted guidewire is also pushed down to bladder.

Sometimes ureteric catheter cannot be pushed up across the stenosis during retrograde examination. Flexible guidewire is left in and during the process of nephroscopy, the guide wire is pushed up into the kidney. It then shows the location of UPJ.

Complete nephroscope set is removed and nephrostomy passage is redilated on one guidewire and the other guidewire is secured. The sickle or straight endopyelotomy knife (Fig. 44, Fig. 68) is used to incise UPJ postero-laterally (Fig. 74) until underlying fat and connective tissue is seen. Length of incision is so that wider bore ureter below stenosis is seen. Benefit of these two guidewires is that the incision is easier in between these two and the other guidewire serves as substitute. An endopyelotomy stent is inserted that has a wider bore above and smaller bore down. We generally use 14/7 or 12/6F endopyelotomy stent among adults (Fig. 67). This stent stays inside for 4 – 6 weeks and then taken out through urethra. Aim of this long term staying in stent is that healing and new scar formation takes place around this stent.

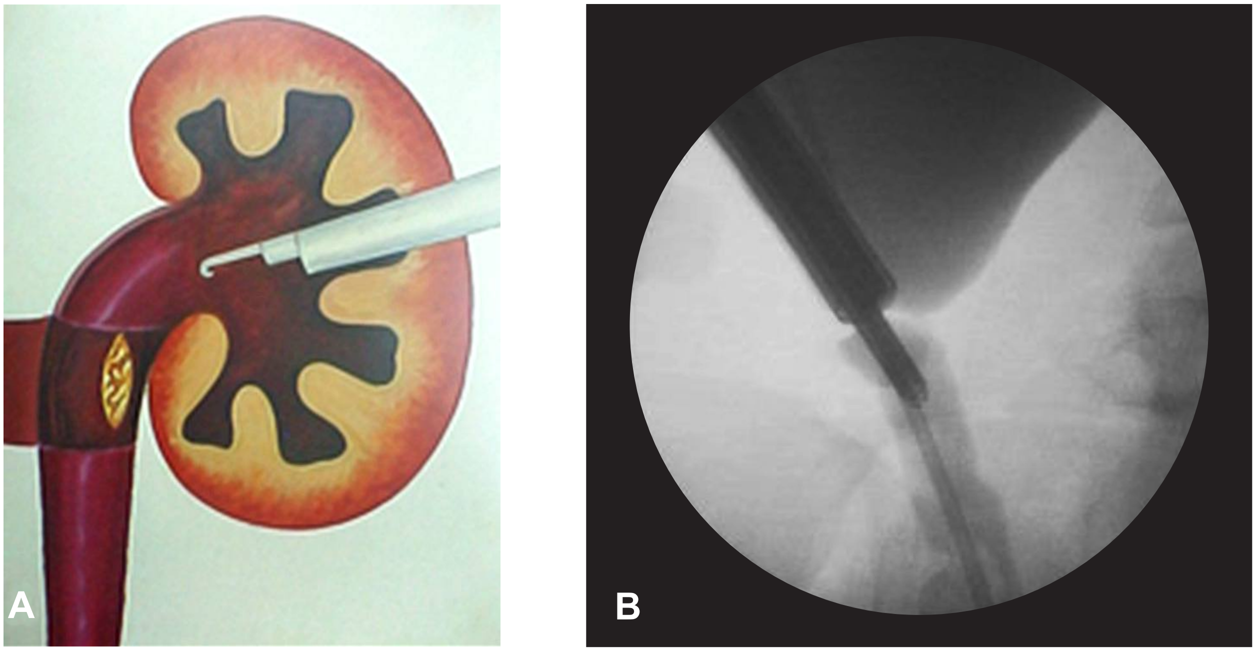

Fig. 74 A. Schematic diagram of endopyelotomy. UPJ is incised till perinephric fat is seen.

B. Endoknife is passed through stenosis to incise it.

At places where the endopyelotomy stent is not available, a 12 or 14F drain (nasogastric tube can also be used) is inserted transrenally till mid-ureter that drains kidney too. Its outer end is outside the skin. It is secured to the skin and closed at the outer end. It stays inside for 4-6 weeks like endopyelotomy stent and then it is taken out from nephrostomy site.

Endopyelotomy[4] can be repeated or if unsuccessful, open pyeloplasty can be performed. It is particularly beneficial in cases where UPJ stenosis developed due to an already performed pyelolithotomy or failed pyeloplasty because an open re-operation is relatively difficult. In cases of congenital stricture or stenosis due to some aberrant vessel the chances of good results are lesser as compared to other acquired conditions when endpyelotomy is performed.

Follow up is maintained at the outpatient department. In the postoperative period patient is asked to contact back if complaints appear. Postoperative IVU X-rays are performed to check passage patency. Simultaneous bilateral endopyelotomy can also be done. Results of one such case have been shown in (Fig. 75).

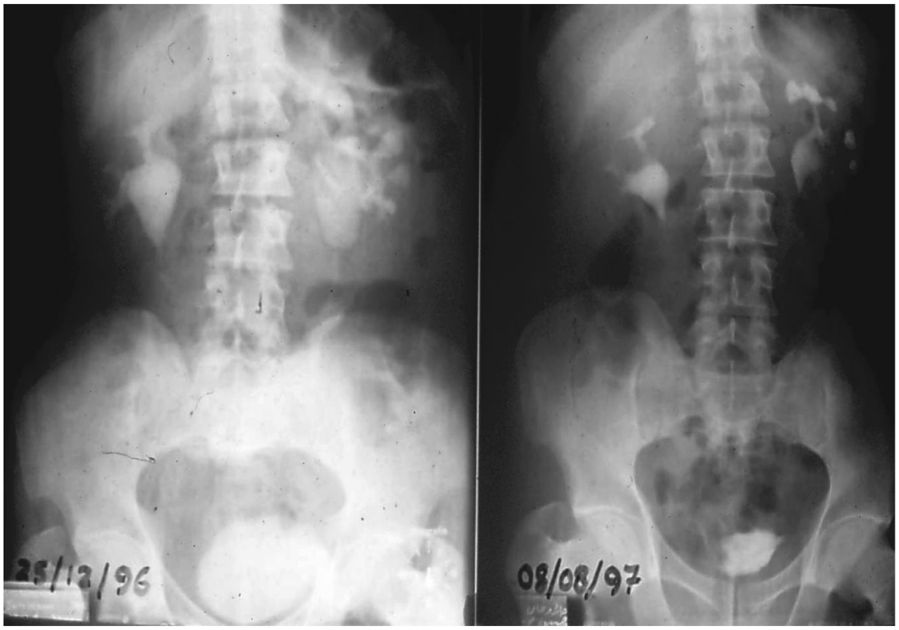

Fig. 75 Simultaneous bilateral endopyelotomy – before and eight months after the operation

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ENDOCALYCOTOMY

9

This procedure is performed in case of calyx diverticulum (Fig. 24) or calyceal neck stenosis (Fig. 76). Diverticulum or stenosed neck calyx may have stones in it (Fig. 77).

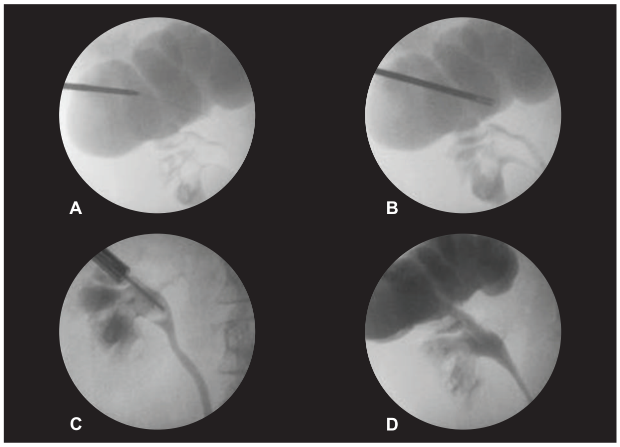

Fig. 76 A. Staghorn stone in pelvis, middle and lower calyces. Upper calyx dilated due to neck stenosis.
B. Channel making to upper calyx.
C. Nephroscope passed and pneumatic lithotripsy probe inserted into pelvis to break the stone.
D. A drain is inserted into the pelvis after dilating calyceal neck.

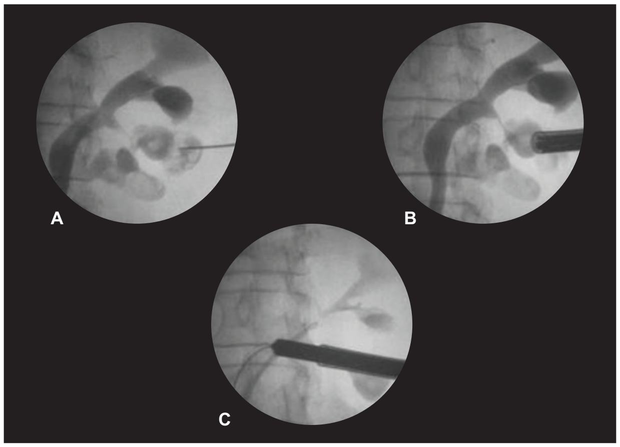

Fig. 77 A. Pelvis intrarenal, middle and lower calyces (both anterior and posterior) with narrow necks having stones, open into pelvis.
B. Middle posterior calyx is approached first to take the stones out.
C. Neck is dilated to pelvis and drain is left inside. All the calyces were touched one by one and procedure was repeated.

A very precise renal puncture is required in such cases. Guidewire can only be pushed till the calyx with stone or into the diverticulum[1]. Channel is dilated till this place only, in the same way as for PCNL. Care should be taken that the equipment does not slip out. Stone is taken out if present. Neck is traced medially (to calyx in case of diverticulum and to the pelvis in case of narrow neck calyx). Blue dye inducted contrast material is pressed from down through already inserted ureteric catheter. It is visualized partly on the monitor and partly through direct vision by tracing blue colour coming out of narrow neck. Guide rod (first of the metal dilator set) is tried to pass through the stenosed neck. If it is not successful, flexible guidewire is inserted in. Nephroscope is removed and channel is dilated again with sequence-wise dilators to the pelvis. The same procedure can be performed from the pelvis into narrow neck calyx (Fig. 78). There are some cases where the neck is not traced at all. In such case a neck is created at an optimal place by viewing on the monitor (Fig. 79). A 20F drain is left inside for three weeks.

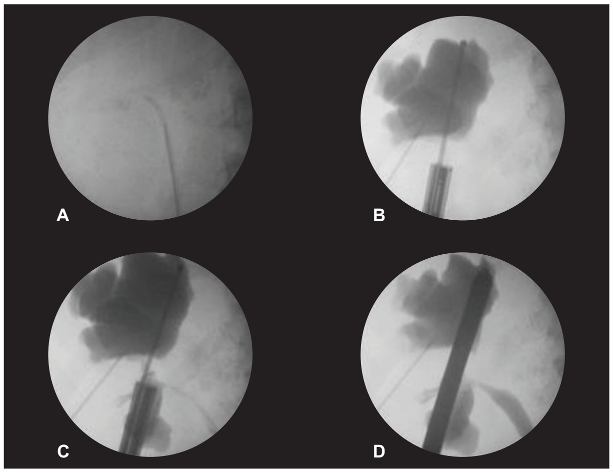

Fig. 78 A. A stone in an already operated renal pelvis.
B. After its removal passage to upper calyx was traced and globule end of long dilator rod was passed through it to upper calyx.
C. Both the cavities were filled with contrast material to get exact situation
D. Channel was dilated and a drain was left inside.

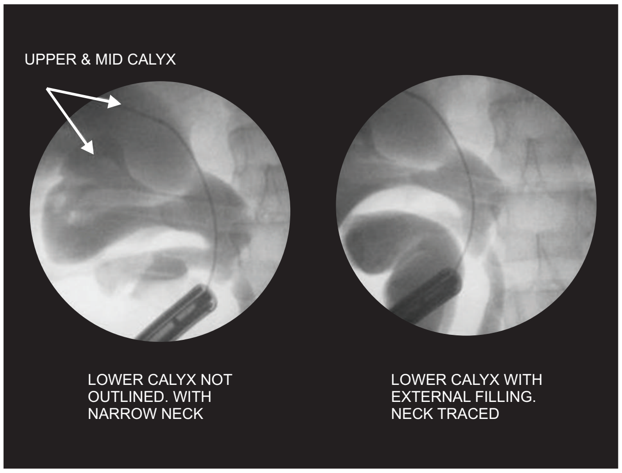
UPPER & MID CALYX
LOWER CALYX NOT OUTLINED. WITH NARROW NECK
LOWER CALYX WITH EXTERNAL FILLING. NECK TRACED

Fig. 79 Lower calyx neck creation

This procedure should be performed while percutaneous surgery experience has been gained. Much vigilance is required during the procedure because difference of a few millimeters cannot give required results. Our aim is not to terminate the diverticulum but to dilate the narrow infundibulum so that urine stagnation, consequent stone formation or infection does not occur (percutaneous calculus metaphylaxis)[2].

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1. Hulbert JC, Reddy PK, Hunter DW et al. Percutaneous techniques for the management of calyceal diverticula containing calculi. J Uro 1986; 135: 225.
2. Thüroff JW, Alken P. Stones in calyceal diverticula: removal by percutaneous nephrolithotomy, in Endourology: New and approved techniques, Jonas U, Dabhoiwala NF, Debruyne FMJ (eds.), Springer Verlag 1988: 133.

PERCUTANEOUS NEPHROPEXY

10

When the kidney is mobile and displaces for more than two vertebrae or five cm while standing and is symptomatic having potential untoward consequences or has an associated stone, nephropexy is performed. This condition mostly appears in lean persons. In severe forms of renal ptosis sometimes kidney is found in the form of lump in the side of abdominal region that disappears when pressed. Though we find different endourological techniques mainly through laparoscopy, fixation of the kidney can be performed with the same equipment that is used for percutaneous surgery[1].

ANAESTHESIA

Local anaesthesia with 0.5% xylocaine along with complementary sedation.

EQUIPMENT & PROCEDURE

Equipment and procedure is the same as that for standard percutaneous surgery.

Mobile kidney is in maximum cephalic position when a ureteric catheter has already been placed in it prior to procedure, the patient lies in prone position and an abdominal cushion supports it from below. Entry in most of the cases is through lower calyx and sometimes upper calyx entry is also used if the kidney is dilated. Stone is removed if present.

In case of lower calyx entry a drain is inserted that crosses pelvis into the upper calyx. It is reinforced by another inner coaxial drain to avoid its bending. That drain stays inside for four days. During that period patient is advised restricted movement to avoid the chances of drain slipping out (Fig. 80).

If the kidney is dilated enough that the balloon of a Foley catheter can be inflated inside the cavity, upper calyx approach is made. After nephroscope insertion kidney is viewed inside for any additional pathology and a Foley catheter is placed in through slotted cannula and balloon is inflated with 2-3 ml of contrast material inside the pelvis (Fig. 81). Catheter is tied to the skin. In this case patient is allowed to freely move around until it is taken out after four days as there is no chance of its slipping out.

Basic concept for renal fixation came from the finding that even an inside scar after a nephrostomy drain insertion is hard to separate when an open operation is performed after some days of its creation[2].

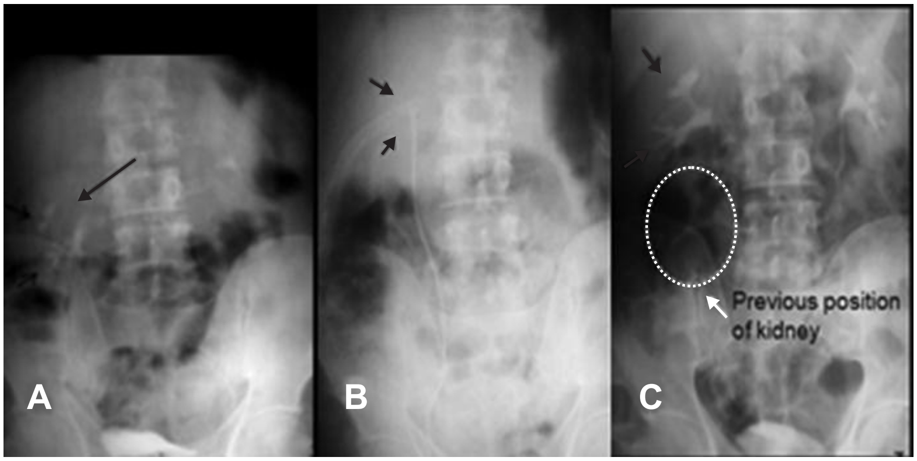

Fig. 80 A. Initial location of right kidney before intervention. It was felt inside the abdomen but when pressed, it disappeared. B. A drain and the ureteric catheter inside. Drain entry is through lower calyx. C. IVU picture after three months of the procedure.

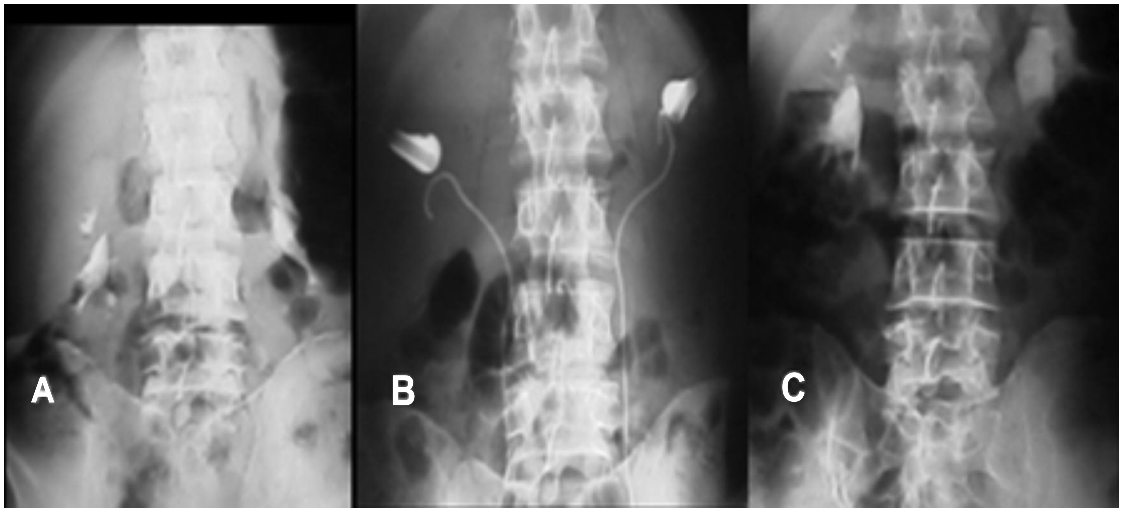

Fig. 81 A. Bilateral renal position before renal intervention. B. Renal approach was made through upper calyces both sides. Balloons of the catheter are visible in both the kidneys. Bilateral DJ stents were inserted. C. Six months postoperative IVU film. Though fullness of both the kidneys was observed but clinically and pathologically patient was healthy.

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2. Khan AM, Holman E, Tóth C. Percutaneous Nephropexy. Scand J Urol Nephrol 2000; 34: 157-161.

ENDOSCOPIC URETER STONE REMOVAL
(Retrograde Ureteroscopy / Ureterorenoscopy)

11

Along with the development of percutaneous operation for stone extraction, endoscopic ureteric stone removal has also gained ground. Special endoscope, ureterorenoscope, through urethra, bladder and ureteric orifice, is introduced upwards till pelvis of kidney and whole of the pathway can be observed. With the help of this instrument different manipulations can be performed in the ureter.

Lyon[1] (1978) and Perez-Castro[2] (1980) wrote about the possibilities of ureter stone removal using electrohydraulic and ultrasonic lithotripsy.

Indications of ureterorenoscopy (URS) are as followed;

1. **Diagnostic Indications**:
    - a. To visualize filling defects of ureter.
    - b. Ureter obstruction.
    - c. Unexplained haematuria.
    - d. Abnormal cytology.

2. **Therapeutic Indications**:
    - a. Ureter stone extraction (ureterolithotripsy ULT).
    - b. Tumour resection.
    - c. Removal of foreign body[3] from ureter.

Hindrances to Ureteroscopy:

1. Large prostatic adenoma.
2. Stricture of ureter.
3. Deflection of ureter.
4. Massive bleeding from upper urinary tract.
5. Stricture of urethra.
6. Stenosis of ureteric orifice.

Contraindications:

1. Bleeding disorders.
2. Untreated urinary tract infection.

Some of the hindrances can be overcome by using more advanced equipment and techniques in urology. Pace of these developments is quite fast since start of endourological techniques, particularly in the last two decades. Where the equipment switched to flexibility and its bore is smaller and smaller, stone breaking amenities are also developing.

We describe the basic technique that is practicable in even developing areas of the world where economic conditions are not of the level of affluent countries.

ANATOMY OF URETER

It is about 30 cm long. It is retroperitoneal and extends from renal pelvis to urinary bladder. Diameter of lumen changes due to elasticity. 12.5F ureterorenoscope can pass through the ureter easily and without causing injury. Wide bore ureteroscope can pass through internal orifice only after dilating it in many cases. There are physiological narrowings in the ureter where the stone can be detained e.g., from above downwards ureteropelvic junction where the ureter comes out of fatty capsule, where it crosses large vessels (common iliac artery and vein) and intramurally at the orifice.

RECOGNITION AND DIAGNOSIS OF URETER STONES

Along with the complaints of patient, it includes urine analysis, ultrasound examination, X-ray examinations (plain X-ray, urography), spiral CT and radioisotope renography.

The stone can be oval, plain surface, high density (whewellite) or it may be spiky having branches all over it, from big crystals to low density (weddellite). It may be irregular, semiradiopaque (struvite, carbonate apatite) or may be radiolucent (uric acid) (Fig. 82).

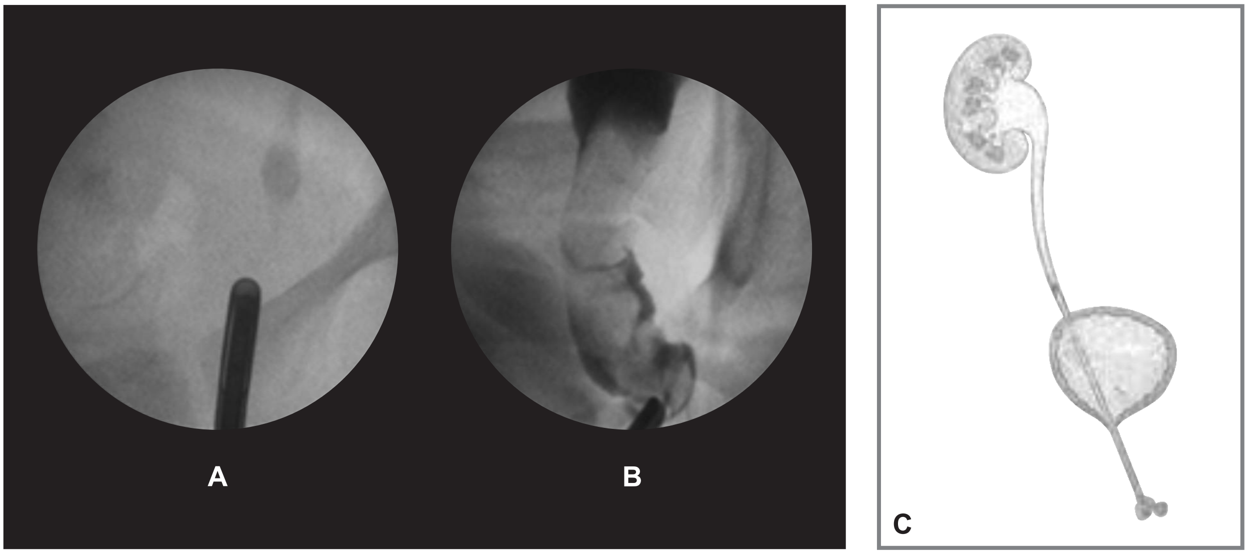

Fig. 82 A. Lower ureter semiradiopaque stone. B. Huge radiolucent stone C. Schematic diagram

The stone in the ureter can completely obstruct the urinary passage. If there is no other complaint than spasmodic pain, it can pass out spontaneously. If temperature or shivering appears, removal is necessary to clear the passage of urine. In case of partially obstructed ureter and presence of relative indications, experience of doctor and real judgment counts. Consent of patient is also important. If the stone is present at the ureteropelvic junction or in the upper part of ureter, it should be taken out through kidney. Transurethral approach is feasible in cases of stones in the lower part of ureter. In case of stone in the middle third either of the approaches may be selected depending upon dilation of ureter above the stone. If mid-ureter stone cannot be approached from above or below, direct percutaneous ureterolithotomy can be performed. Its detail will be mentioned seperately.

In case of multiple small stones or steinstrasse in the ureter (Fig. 83) even only a double J stent is sufficient. Stones will pass out spontaneously. In such cases usually a larger fragment occludes the passage hindering other stones to pass down.

EQUIPMENT, SET-UP

Ureterorenoscopy or ureterolithotripsy is also considered as an operation. Operation theatre should have the possibility to be darkened. Operation table or cystoscopic examination table should be radiolucent. The patient lies on the table in lithotomy position. X-ray image intensifier is adjusted accordingly on the body.

Cystoscope operating sheath:

20 or 22F size sheath is mostly used among adults. It is introduced into the blabber along with its obturator. It has inlet and outlet for irrigation fluid. If cystoscope is not

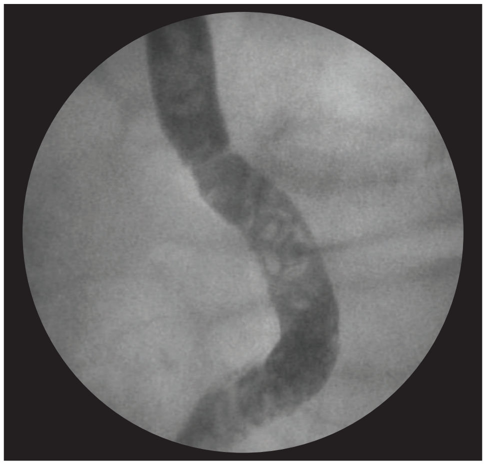

Fig. 83 Multiple stones in the ureter in the form of steinstraße

available, nephroscope sheath (26F) can be used for this purpose among adults (Fig. 42D).

Cystoscope telescope:

It can be inserted through operating sheath. It is used to view inside the bladder before ureteric intervention.

Light source, Light cable:

Same as used in percutaneous surgery.

Deflector mechanism:

It is used mostly with 70° cysto-telescope. It is used to deflect ureteric catheter tip and guidewire in it to required position so that its insertion into ureteric orifice becomes easier. After gaining some experience, ureteric catheter can be inserted even with 0° telescope and the deflector mechanism is not required.

Guidewire:

Variety of flexible guide or glide wires is available now in the market. Aim is that it should not pierce ureteric wall during its retrograde insertion.

Dilator series:

Teflon 9 - 12F and metal 9 - 13F size are being used to dilate ureteric orifice.

Ureterorenoscope:

Though narrow bore and flexible ureteroscopes are available and being utilized at different centres successfully we frequently use ureterorenoscope from Storz (Perez-Castro Ellendt type) among adults. It is of 12.5F size with continuous irrigation facility having in and outlet taps and instrument channel with two openings. One is used for Dormia basket or stone grasper introduction and the other one for ultrasound probe or stone grasping forceps. For this size ureteroscope sometimes ureteric orifice dilation is required.

URS telescope:

With the viewing angle of 6 degree (Fig. 84A)

Stone grasping forceps: (Fig. 84B)

Ultrasound generator and suction system / Pneumatic lithotripsy system.

Ultrasound Probe (Fig. 84C) **/ Pneumatic lithotripsy probe.**

Irrigation fluid:

This is isotonic saline solution. It may be in two or five litres bottles, or normal saline in a container. That container should be present at a height of approximately 60 cm.

In and outflow tubes.

C-Arm X-ray image intensifier.

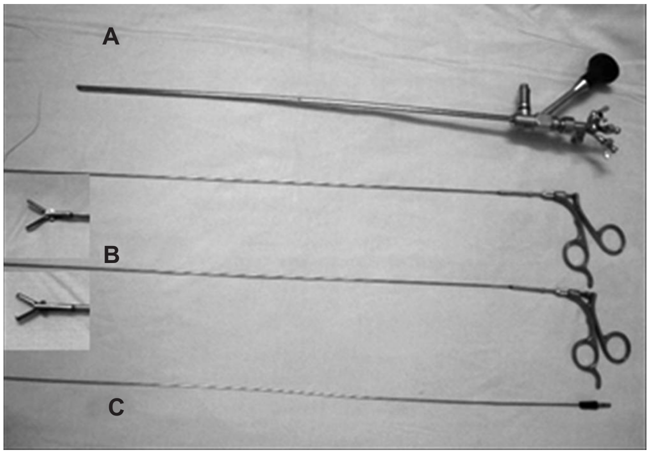

Fig. 84 A. Ureteroscope
B. Two types of stone grasping forceps
C. Ultrasound probe

EXAMINATION OF PATIENT AND PREPARATION

It takes place in the same way as for the patient with kidney stone. Patient is given sedatives before operation.

There are some stones which can be pushed up into the pelvis. Those may be in the upper ureter or the ureter is dilated above the stone. It depends upon their size, position and surface. If simple pushing up is unsuccessful in such stones, it is worthwhile to inject contrast material through the ureteric catheter which lubricates the surfaces and the stone may move up. If the stone is pushed up by this manoeuvre, it is removed percutaneously. If it does not succeed, ureterolithotripsy is performed.

ANAESTHESIA

Spinal or epidural anaesthesia is used according to the choice of the anaesthesiologist. Its complete effect appears within 5-10 minutes from umbilicus caudally in the body. Effect may remain for 6-8 hours.

POSITION OF THE PATIENT

The patient lies in lithotomy position. Leg on the opposite side is high and on the same side low regarding the stone. Manoeuvre is easy in this way. Site around the urethra is disinfected with iodine or alcohol. After that the patient is draped with sterile sheets.

Operator, assistant and O.T. nurse scrub up and wear gown along with lead apron.

DILATION OF INTERNAL ORIFICE AND INTRAMUSCULAR PART OF URETER

Cystoscope is introduced into the urinary bladder through urethra. Bladder is filled with sterile clear fluid and it is thoroughly observed for any other pathology. A guidewire is introduced through the orifice into ureter on the side of stone. If the guidewire is in a ureteric catheter, it is easy to insert. Proximal end of ureteric catheter rests at orifice and guidewire is slid in. Guidewire may cross the stone or stops when it reaches stone.

Orifice is observed if ureteroscope can pass through it. In many cases it is successful without dilating it. If dilation is required, it can be performed with metal or Teflon dilators. Expandable balloon dilator may also be used. Metal dilators are pushed into the orifice in sequence on the guidewire. Smallest is 9F size, next is 10.5F and largest in the size is 13F. Among Teflon dilators 12F is the largest one which is introduced into the orifice.

Cystoscope telescope is taken out but its sheath is left in bladder and guidewire in the ureter. Light cable is attached to ureterorenoscope and it is slipped on the guidewire. This is partly performed by looking through telescope and partly by X-ray control and guided into ureter.

To introduce the instrument through orifice rotatory movement is required, internal end is lifted up a bit and some pressure is applied cranially. This movement is observed on the fluoroscope monitor lest the guidewire bends and instrument pushes the wire into the lumen of bladder.

As the orifice is crossed the instrument is pushed forward gently into the direction of kidney with the outer end lowered simultaneously. For the successful results without hindrance, in some cases operation table is lifted to such an extent that the ureter is at the same level as the eye of operator. Ureterorenoscope can be driven up to the pelvis of kidney.

If the Teflon dilators are used, after the passage of guidewire into the ureter, cystoscope along with the operating sheath is removed and the guidewire remains inside. Teflon dilators are slipped on the guidewire up till the stone. Outer Teflon sheath is left inside and the dilators along with the guidewire are taken out. Ureteroscope is inserted in through the sheath and the stone is visualized.

URETEROSCOPY

After inserting the ureterorenoscope, fluid inlet is opened and the ureter is visualized thoroughly. If the outlet is still close, fluid does not go out immediately and ureter is dilated a bit. Its internal look is now clear. In many cases only dark red field is seen on first sight. It may be due to small blood clot which can be sucked or taken out with a coagulum forceps. If these manoeuvres are not successful, a 20 ml syringe is filled with normal saline, inflow is blocked and from outflow tap it is injected with pressure, clot may clear away. The other reason for this dark red field of vision is that ureteroscope is aimed at the wall and not looking into the cavity.

Wall of ureter is observed concentrically while moving upwards till the stone stops the way. In most of the cases edema of the wall is seen around the stone. Hyperaemic area easily bleeds even if it is touched lightly. Impacted stone for weeks can cause such edema of mucous membrane that the instrument cannot be pushed forwards. Sometimes it is successful to remove the stone in complete. Time of intervention is very short in such cases as compared to disintegration and removal.

During the manoeuvre of ureteroscopy fluid may push the stone upwards in the ureter or into the renal pelvis. In such a case it should be followed and if possible it is held with stone grasping forceps, if its surface is plain and size is optimal it is taken down through ureter. If its surface is rough and spiky and size is larger, ureteroscope is taken out. Ureteric catheter is left inside and stone is removed percutaneously. Drifting away of stone can be avoided if it is held in a Dormia basket. It is somewhat helpful if the inflow is stopped but then the field of vision is not clear. In such case endoscopic visualization is not possible, and the manoeuvre can only be observed on the fluoroscope monitor.

URETEROLITHOTRIPSY

To remove relatively large impacted stone in the ureter, it should be disintegrated. It is better if a balloon ureteric catheter can be pushed up cranially crossing the stone and inflated. If there is a chance that Dormia basket can be pushed up, the stone can also be grabbed in it and then disintegration takes place. Stone migration or drifting away with the current of fluid can be avoided by this method. Raising the head end of the table to maximum possible can also help stone to stay at lower level in some cases.

In case of ultrasonic stone breaking, ultrasound oscillation producing generator and suction system is the same as that for renal stone cases but the probe is longer and thinner. This probe can only be inserted into 12.5F ureterorenoscope if Dormia basket is not driven in through the instrument channel. Both of the instruments can be accommodated in if the outer sheath of the basket is taken away and from the side hole the basket is introduced in. The probe can only be inserted through the instrument channel because it is not flexible. The new and larger inside bore ureteroscopes allow two instruments at the same time into the instrument channel e.g., probe and Dormia basket or the basket and stone grasping forceps.

The end of probe is placed on the stone and disintegration is started. With slight pressure the probe is set on the stone till it breaks into pieces. Soft stones can be smashed to such an extent that the pieces can be sucked out if suction system is incorporated. After breaking, larger pieces are removed with stone grasping forceps. All the removed pieces should be procured for analysis. Fragments of stone are tried to be taken out completely but if small fragments of millimeter size remain inside, these do not create any problem. Diuresis can wash those out. Even large size stone can be broken into smaller fragments and it can be left inside. Stenting is necessary in such cases.

As the ureter is clear of stone, it is irrigated, wall intactness is checked. If there is no residual fragment and there is no injury ureteroscope is taken out. In doubtful cases ureteric catheter is placed inside for 24 – 48 hours or if necessary a DJ stent is left in. With this stenting postoperative urinary obstruction due to edema is prevented. Internal orifice remains open for long time after its dilation (Fig. 85). If ureter is perforated during the intervention there is no need for an open operation. Stenting for some days, good observation and parenteral antibiotics can help healing without complications. If significant mucous membrane injury or perforation takes place, a DJ stent is left inside for 3-6 weeks. We had patients having ureterocele and it caused stone formation and difficulty in micturition (Fig. 86). Ureteric orifice can be incised and the stone can be removed[4]. Cystoscopic scissor can be used for this purpose. Cold knife is preferred on electric cautery incision to avoid chance of stenosis.

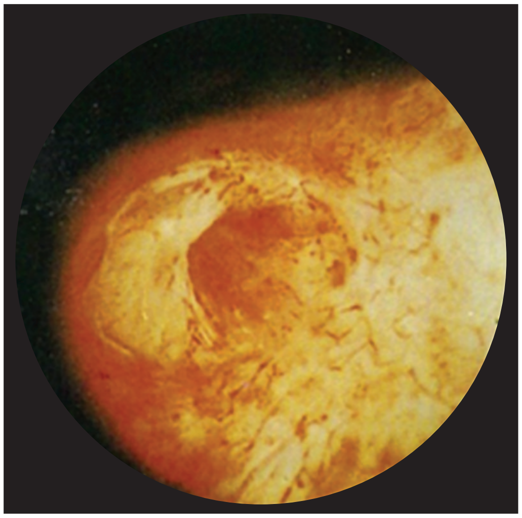

Fig. 85 Ureteric orifice remains dilated for a long time after ureteroscopy

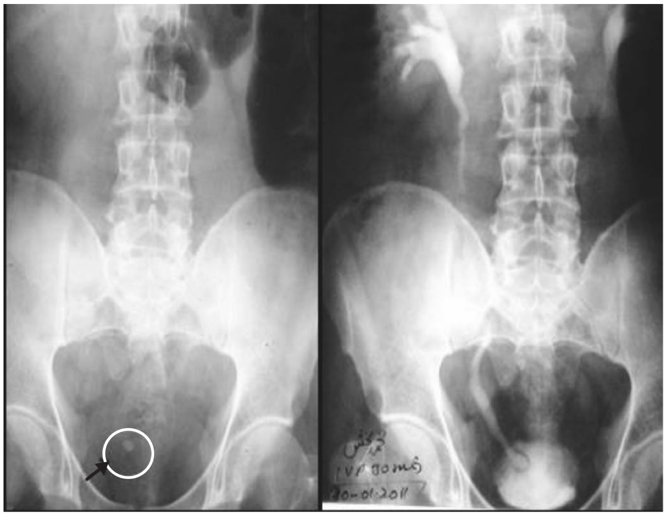

Fig. 86 A stone at the lower end of right ureter in a ureterocele

If electric cautery is used, normal saline should not be used for irrigation. A DJ stent is inserted if required.

Effects of DJ stent

Many patients complain of kidney pain during micturition. This is due to noncompliance of normal valvular mechanism that stops upwards flow of urine during micturition. Patient is advised to micturate slowly, just allowing it to pass out.

Patient might have complaints of frequency and urgency and sometimes burning micturition. Abundant fluid intake may reduce the symptoms.

Sometimes the patient is febrile. That may be due to free up and down flow of urine and migration of infection. It is noted that almost all the patients have more pus cells in urine while having a stent inside. Plenty of fluid intake will dilute the urine. Appropriate antibiotic is given in case of infection.

If a stent remains inside for longer period, it may be encrusted and stone forms on it (Fig. 70C). It may also turn fragile and can break inside if tried to remove after long period of its insertion[5].

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PERCUTANEOUS TRANSRENAL URETER STONE REMOVAL

(Antegrade Ureteroscopy)

12

If the stone is high in the upper or middle part of ureter, it may also be removed percutaneously through kidney[1]. In such cases first we try to push it up with the help of ureteric catheter. This procedure can be helped by lubricant fluid e.g., with X-ray contrast material, from below. If it is successful to push the stone into pelvis, it is taken out easily.

If upward pushing is not successful, ureteric catheter is tried to push up by the side of stone otherwise left below the stone. Percutaneous channel should be selected so that the line of entry into the ureter is maximally straight. Upper or middle calyx is chosen for puncture and this is mostly through intercostal approach.

Renal pelvis is approached in the same way as for primary percutaneous renal stones extraction. As the nephroscope is inserted, renal cavity is thoroughly visualized. If the UPJ and the ureter is dilate enough above the stone, nephroscope is inserted in as down as possible. Already inserted ureteric catheter may be pulled down below the stone at that time for better manoeuvreability. If the stone is seen it is taken out with the help of forceps. It is taken out slowly so that the ureter does not get splitted or torn. Invagination of ureter should also be avoided. If this manoeuvre is futile, Dormia basket is tried or by holding it within the basket ultrasound probe is lead inside and the stone is tried to be disintegrated.

If these manoeuvres are not workable, nephroscope telescope is removed while the sheath remains inside. Ureteroscope is introduced in through the sheath. That sheath helps preventing excessive bending of the ureteroscope lest its lens system is damaged. Entry into the ureter is made under direct vision (Fig. 87) or with the help of guidewire. The Manipulation here, apart from the improvisations, is the same as that of transurethral ureteroscopy. The stone can be taken out as such with the help of stone grasping forceps, Dormia basket or Zeiss loop. If required, stone disintegration is the same as done with the retrograde approach. Large particles are taken out carefully. A DJ stent is inserted for passage patency and small particles to flow out spontaneously (Fig. 88). It gives certain surety of their drainage if all the particles cannot be taken out.

During antegrade stone removal, pressure of normal saline mixed with contrast material through the ureteric catheter that had been pulled back below the stone helps taking it out as such due to lubrication as well as in case of disintegration, small fragments flow up and are taken out easily. Ureteric contour should be viewed on the image intensifier monitor during this manoeuvre.

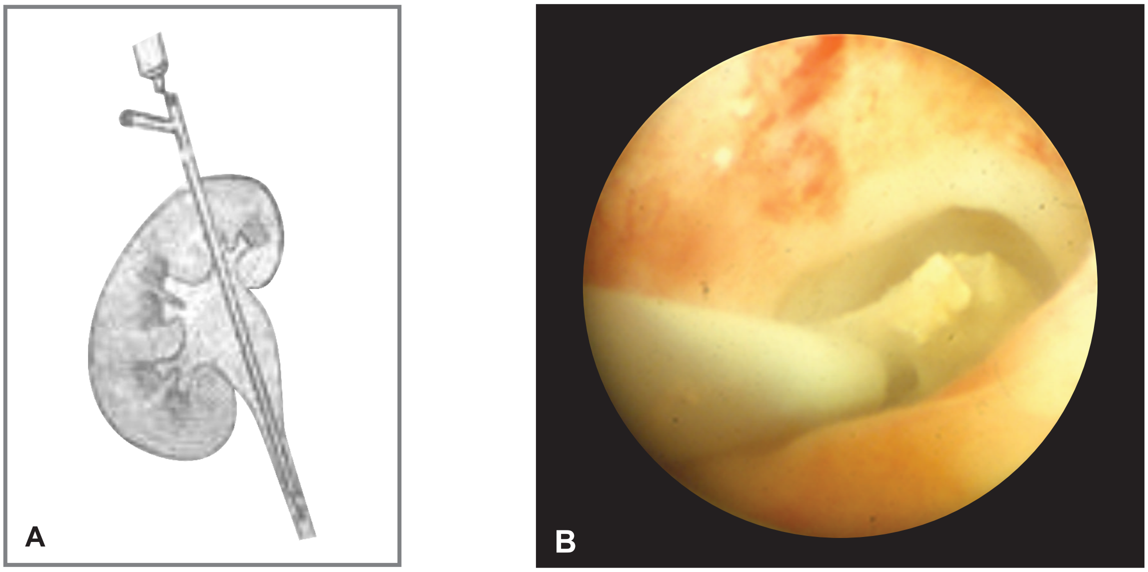

Fig. 87 A. Schematic diagram of antegrade procedure.
B. Stone is visible in mid-ureter through antegrade ureteroscopy.

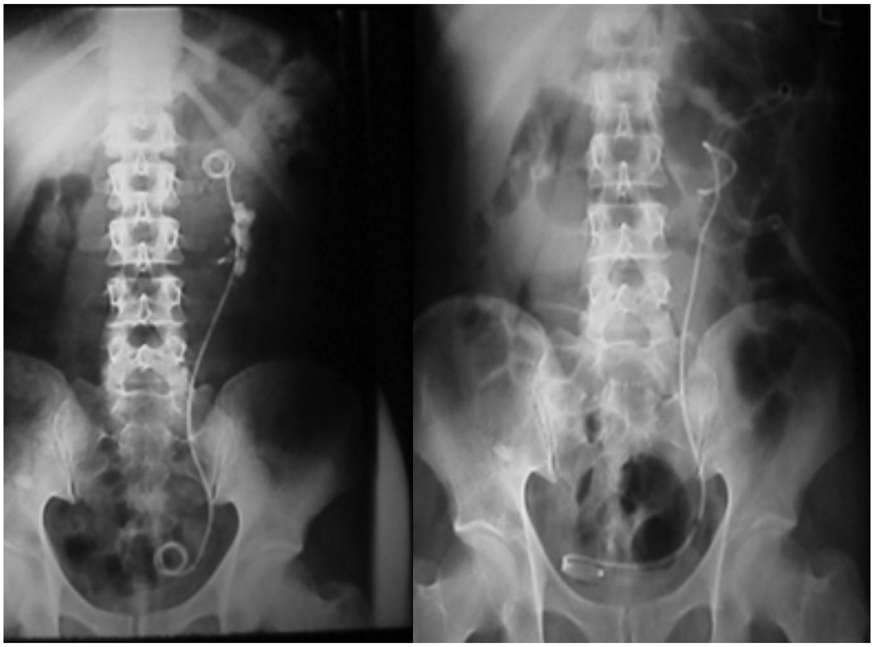

Fig. 88 Stones in left upper ureter. Pre and postoperative X-ray films.

After Percutaneous stone extraction when the ureter is not damaged and whole of the stone is removed, ureteric catheter is not put in; only nephrostomy drain is left in for 1-2 days. Drain may be closed immediate postoperatively for orthograde passage patency. Before removing the drain, cavity is filled with contrast material and checked through X-ray. It should pass through ureter into the bladder without hindrance. If the passage is clear the drain is taken out.

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PERCUTANEOUS NEPHROSCOPIC URETEROLITHOTOMY

13

There are cases in which ureter is stenosed above and below the stone or middle ureteric impacted stone could not be reached from above or retrograde. We performed direct percutaneous nephroscopic ureterolithotomy in about 150 cases (Fig. 89). This method is certainly useful as compared to open ureterolithotomy for such stones but only after gaining experience for percutaneous surgery[1].

Spinal or general anaesthesia is used for the operation. An open end ureteric catheter having flexible guidewire in it is inserted prior to operation till it reaches the stone. Equipment and the approach is the same as for renal percutaneous surgery. Stone is targeted at puncture and the channel is dilated till the ureter. Skin entry point is relatively medial to posterior axillary line and is almost as steep as the puncture of kidney. Expanding movements of alligator forceps is used for blunt dissection around the ureter where the stone is present. A longitudinal one cm incision is given on the ureter with the help of straight endoknife used for endopyelotomy. The stone is taken out and guidewire is advanced up to kidney. Either the same ureteric catheter is pushed up or a DJ stent is inserted. A periureteric drain is left inside that may take one to two days to be completely dry.

Complete procedure can be viewed in European Urology Video Journal Vol. 3, Nr. 4 December 1996[2].

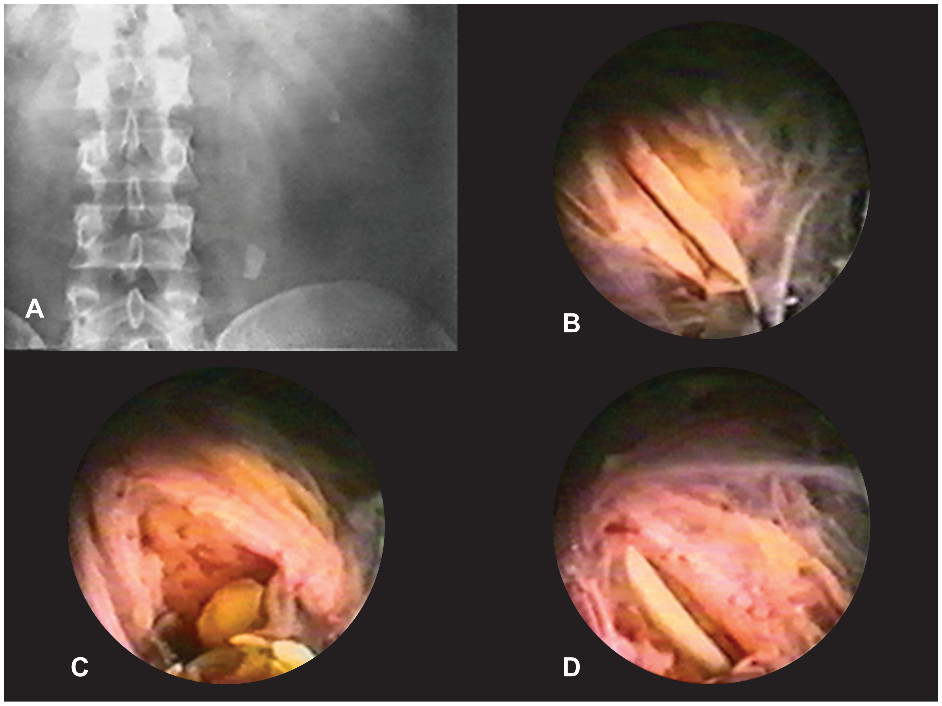

Fig. 89 A. Stone in the mid-ureter.
B. Longitudinal incision on the ureter at the site of stone.
C. Stone taking out.
D. Pre-inserted ureteric catheter is pushed up.

RELATED READING / VIDEO:

1. Tóth C, Varga A, Flaskó T. et al. Percutaneous ureterolithotomy: direct method for removal of impacted ureteral stones. J Endourol 2001 Apr; 15 (3): 285-90.
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ENDOSCOPIC URINARY BLADDER AND URETHRAL STONE REMOVAL

14

Transurethral mechanical vesicolithotripsy can be done with the help of stone punch or lithotrite (Fig. 90). If this particular equipment is not available nephroscope and ultrasonic or pneumatic disintegrator for percutaneous stone surgery can also be used for the stone in the urinary bladder or urethra among adults.

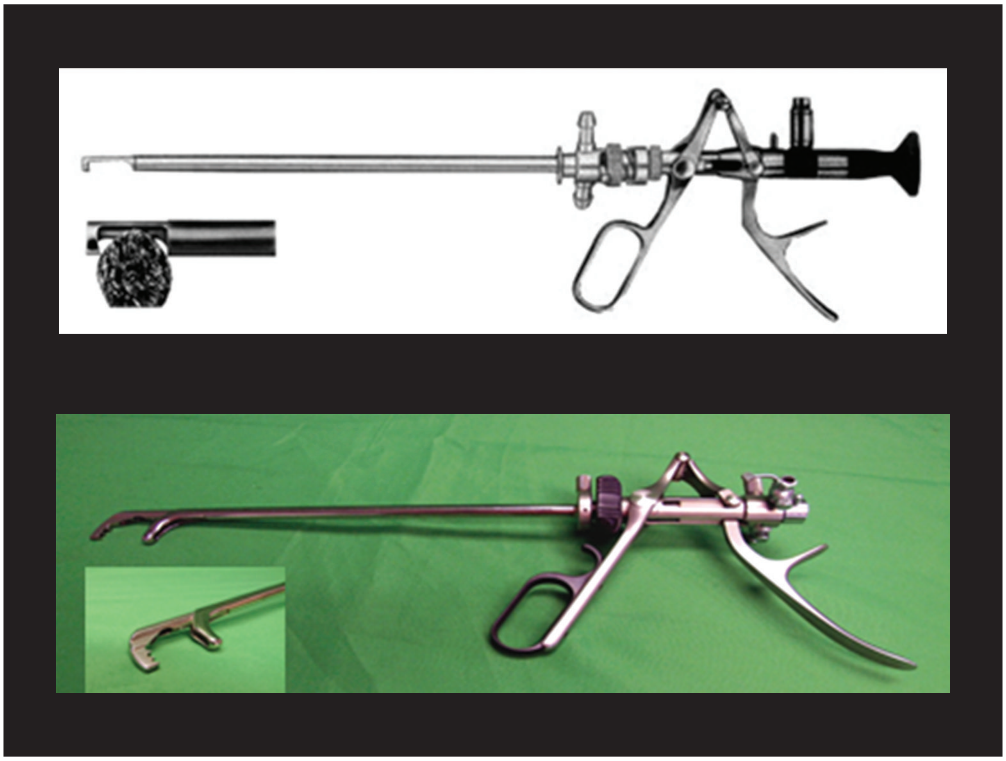

Fig. 90 Two types of mechanical stone crushers. For smaller as well as larger stones.

Perurethral removal of bladder stone is on old human wish. Martin (1782) prepared a file and used it for bladder stone through months. Later on, as the surgical application of this technique, Civiale (1823) and Thompson (1850) brought an end to the era of European wandering surgeon like Father Jacques who removed bladder stones. Optical stone disintegrators replaced that era too. Next step was electrohydraulic and ultrasonic stone disintegration which proved good in renal cavity and equally useful for breaking the stones and suction and washing out the particles from the bladder and urethra. Then were invented the methods of pneumatic and laser stone disintegration.

Indications

1. Solitary or multiple (Fig. 91) stones in the urinary bladder
2. Impacted stones in the urethra (Fig. 92)

Contraindications

Anaesthesiologist can ascertain which kind of anaesthesia can be given after examining and declaring that the patient is fit for surgery. Otherwise there is no contraindication for the transurethral stone removal from the urinary bladder. Nephroscope is difficult to introduce in cases of meatus stricture, prostatic hypertrophy and prostatic carcinoma. Also the impacted stone in the urethra does not allow the instrument to pass by.

Recognition of vesical stone starts with the complaints of patient and judgment of the doctor for the

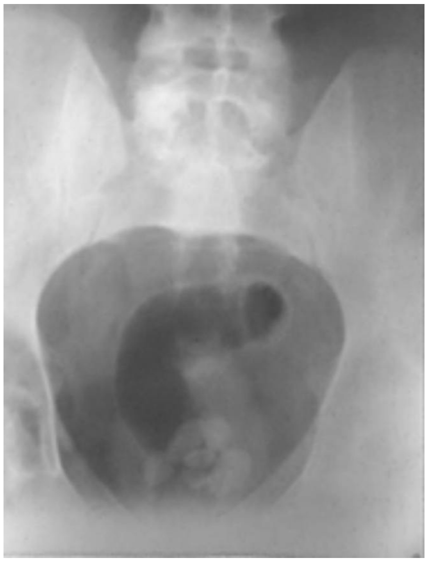

Fig. 91 Multiple urinary bladder stones

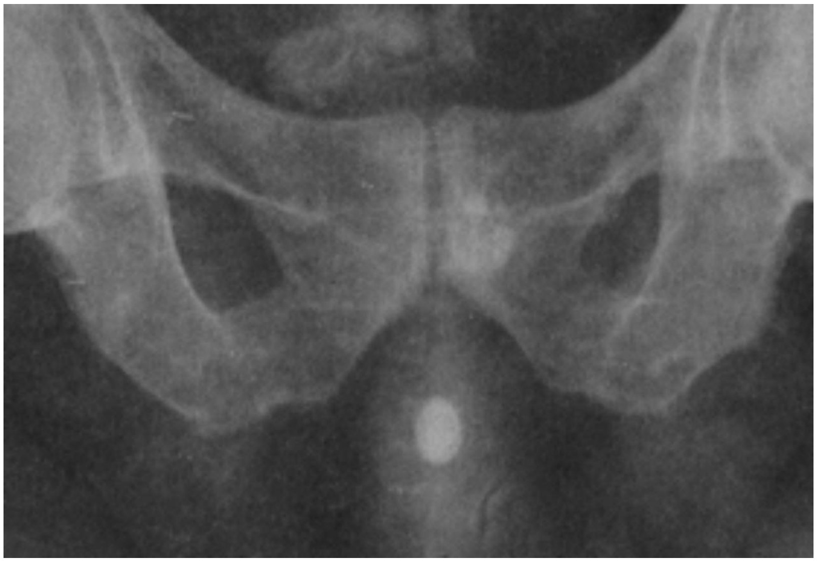

Fig. 92 Impacted Urethral stone

disease. Frequent desire to micturate, obstruction in the stream of urine, vesical tenesmus and blood stained urine urges doctor to perform ultrasound examination, X-ray examinations (plain film, cystography) and cystoscopy. Confirmation of diagnosis is the indication for operation.

In case of impacted urethral stone complete urinary retention, weak stream or just seepage and in case of impacted stones near the meatus branching stream draws the attention of the doctor. X-ray examinations (plain X-ray, urethrocystography) confirmed the diagnosis.

Generally, the stones in the bladder do not need acute intervention but impacted stones in the urethra should be removed immediately if they cause difficulty in emptying, urine retention and the symptoms are severe.

Stone, which gets stuck in the urethra, may cause decubitus of the wall and infiltration of urine even if complete retention of urine has not occurred yet. These may cause formation of pus and patient can go into septic condition.

The removal of urethral stone with the help of grasping forceps or the Dormia basket or pushing it back into the bladder with the help of catheter is rare without injuring urethra. In such cases catheter is left inside for longer time.

EQUIPMENT SETUP

- Endoscopy Room (with the facility to darken it): The place where cystoscopy is performed is also suitable. Image intensifier is not required for the intervention.
- Cystoscopic examination table
- Operating Sheath: Size is 26F. It is used with Nephroscope (Fig. 42D).
- Nephroscope
- Light Source, Light Cable
- Irrigation Fluid with in and outgoing tubes.
- Ultrasound generator, suction apparatus, probe for disintegration. Electrohydraulic impulse generator or pneumatic lithotripter, whichever is available, may also be used.
- Stone grasping forceps (Fig. 43)

Examination and preparation of the patient is the same as that of percutaneous stone extraction or any other surgical intervention.

ANAESTHESIA Same as for ureterolithotripsy.

DISINTEGRATION OF BLADDER STONES AND REMOVAL

Patient lies supine in lithotomy position. Sterilization measures for bladder cystoscopy should be maintained.

Nephroscope operating sheath with its obturator is introduced into the bladder. Nephroscope is inserted in place of obturator. Light cable is attached to it and its outflow is attached to suction system if required. Outflow may be left open (without suction) if the field of vision is clear during manoeuvre. Inflow of sterile clear fluid is turned on so that the bladder is distended to required extent. Ultrasound probe is passed in through the instrument channel of Nephroscope, and guided to the stone. The stone is pressed against the opposite wall with slight pressure. Now the ultrasound generator and suction system is turned on. Probe is held on the stone until it cracks and splits into pieces. Time taken for disintegration depends upon the composition of stone. Whewellite stone is the toughest one to be broken. Somewhat easier are the anhydrous crystals of uric acid. The easiest to be broken are struvite and carbonate apatite stones.

The particles of stone are partly sucked out and partly taken out with stone grasping forceps. Bladder is cleared of stone and balloon catheter is put in. If required, bladder is irrigated for a few days with antibacterial acidic (pH 4)[1, 2] or alkaline (pH 8) solution through a three way catheter. Acidic agent (hemiacidrin) is used for struvite and carbonate apatite stones formed in infected urine with proteus or pseudomonas aeruginosa. Alkaline agent (Liotris) is used in case of uric acid stones. Oral medicines for the same effect are used in long term management. If the cause of stone formation is anatomic (e.g., prostatic hyperplasia) it should also be resolved, if possible endoscopically (TUR).

URETHRAL STONE DISINTEGRATION AND REMOVAL

In urethra, nephroscope can be inserted till the stone. In most of the cases it is present in the membranous part of urethra (Fig. 92). With fluid irrigation and good illumination, ultrasound probe can be guided to the stone and it is broken.

Large particles can be taken out with alligator forceps and smaller ones can be sucked out. Balloon catheter is placed in through the stone-free urethra. Antibiotic therapy is started. Site of stone formation and cause is tried to be determined to avoid recurrence of stone in the follow up period.

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ENDOSCOPIC URINARY BLADDER STONE REMOVAL IN CHILDREN

15

This procedure is known as percutaneous suprapubic vesicolithotripsy (PCVL) (Fig. 93) or percutaneous cystolithotripsy (PCCL)[1]. Pioneering this procedure, first time it was presented at WCE at Melbourne, Australia in November 1996. It is applied to children with urinary bladder stones where the caliber of urethra is too small. Like other endoscopic procedures, this causes lesser trauma to the patient with perfect results as compared to open operation. Same equipment is used as for percutaneous nephrolithotomy.

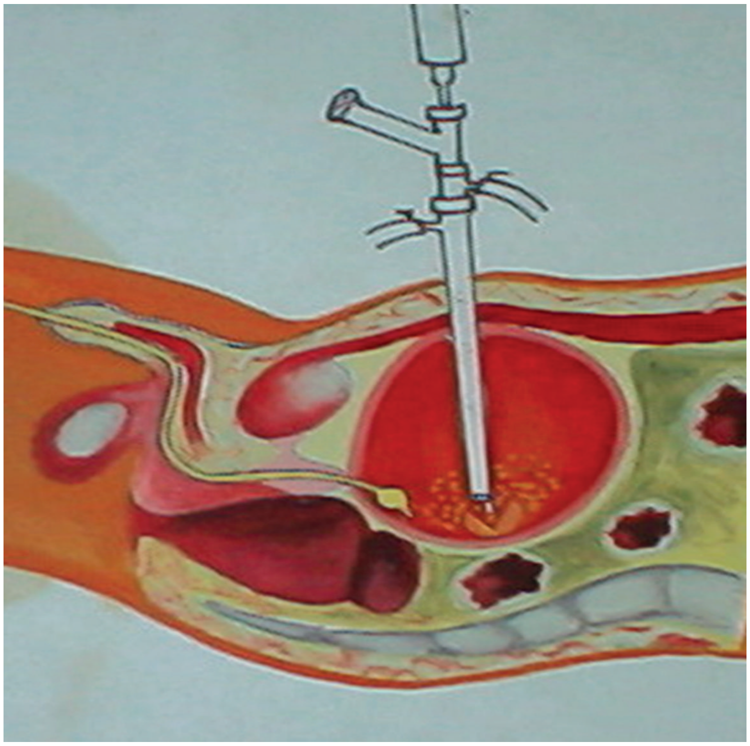

Fig. 93 Schematic Diagram of Percutaneous Vesicolithotripsy

Indications

- Stone in the urinary bladder regardless of the size, consistency or number.
- Too young children or infants where the endoscopic lithotripsy equipment cannot be passed through urethra or it is vulnerable to injury if such equipment is passed through.

Contraindications

- Generalized weakness of great degree.
- Untreated urinary tract infections
- Bleeding disorders.

If the patient is contraindicated for surgery, first the patient is brought into favourable condition after Foley catheter insertion and then he is operated.

PREPARATION OF PATIENT

The patient is prepared the same way as for open vesicolithotomy. Enema is necessary before the operation. Premedication mostly consists of Atropine 0.25 mg and Diazepam 5 mg which is given one hour before intervention. It can be changed according to the advice of anaesthesiologist.

The patient is operated under general anaesthesia. This ensures complete relaxation of the patient and the abrupt movements of the innocent patient can be avoided.

POSITIONING OF THE PATIENT

The patient lies on the operation table in Trendelenburg position which helps intestines to roll back cranially. Intestinal injury can be avoided in this way. As the X-ray image intensifier is not required in such operation, the operator stands on one side of the patient and the assistant on the other side with the trolley.

PROCEDURE (Fig. 94)

Foley catheter is inserted into the bladder prior to operation. Its external end is attached to a normal saline infusion to fill the bladder. Patient is cleaned and draped in the traditional way as in open vesicolithotomy.

Fluid is allowed to flow in through the catheter till the bulge of urinary bladder is observed suprapubically. The peak of the bulge is felt with a finger and puncture needle is inserted into the bladder caudle to the finger, in the midline suprapubically, until the bladder is pierced and the fluid mixed with urine flows out of the needle. A guidewire is inserted into the needle and the skin is incised for one centimeter at the point of needle insertion. Guidewire is left inside and the needle is removed. The channel dilation is the same as for nephrostomy channel making and nephroscope is introduced in. Retrograde inflow of normal saline is stopped and in and outflow channels of nephroscope are opened. The stone is taken out as such or if large, after disintegration. After the stone removal a suprapubic drain is inserted through the outer sheath of nephroscope and is fixed to the skin. Catheter remains inside and suprapubic drain is blocked.

The important point during the dilation process is that it should be fast enough so that the fluid does not spill out. If the wall of the bladder is stretched, the dilation is easier but the bladder should not overstretch. Overstretching may cause perivesical fluid accumulation. During the process of puncture and dilation the needle and fascia dilators should not go so much deep that the opposite wall of urinary bladder is pierced. This danger becomes lesser after passage of guide rod.

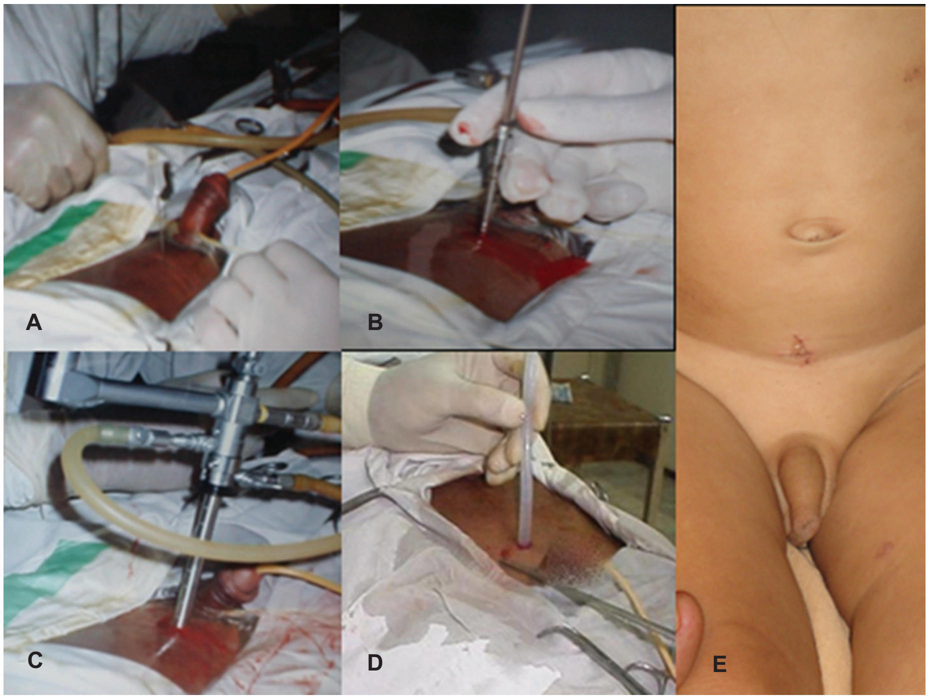

Fig. 94 A. Foley catheter inside and bladder puncture B. Dilating the channel C. Nephroscope inside D. Drain insertion after stone removal E. Wound of PCVL

The suprapubic drain is taken out after few hours of operation depending upon the colour of urine, but Foley catheter stays in for about two days. According to our experience, an extra hole made on the tip of the Foley catheter helps drainage a lot. This comes out from the fact that the internal diameter of the catheter is too small and the original eye on it is relatively smaller, which can get occluded with a clot while the suprapubic wound is raw. The chance of extraperitoneal accumulation of urine or fistula formation is more if the catheter gets occluded for a few hours and it is important to mention that the patient is too young to complain about the problem. Patient of nine months of age was the youngest one operated upon by us through this method.

ADVANTAGES

As compared to open operation, this procedure is quite safe and effective, regarding its trauma and postoperative complications. Incision is too small, scar can hardly be seen and cosmetically acceptable. Internal anatomy is disturbed to a minimum extent. In case of future surgical intervention, exploration of inner structures is easier.

Transurethral stone extraction as performed among adults is not an advisable route for stone removal among babies and younger children. Delicate urethra is very much prone to injury causing complication like urethral stricture, and the child may suffer for whole life. Furthermore, even if the intracorporeal lithotripsy equipment has been passed transurethrally, the stone cannot be evacuated until it is converted into fine granules, which is quiet difficult in many cases.

COMPLICATIONS

Haemorrhage:

Haemorrhage is an inevitable complication which may arise in any surgical procedure. However, we did not face such severe haemorrhage in PCVL where the patient had to be opened to search for the injured vessel. In our opinion, ordinary bleeding can stop by the compression of bladder wound around the suprapubic drain which keeps the bladder in collapsed form by maintaining continuous flow of urine through it and the catheter.

Peritoneal perforation:

This can be avoided by completely filling the urinary bladder. In this way, peritoneum rolls back cranially by providing the free bladder surface to be puncture. If the peritoneum is injured, it becomes necessary to open the patient to clear the cavity of fluid, to search for any gut injury and to repair it. It can be recognized by generalized abdominal distention in the earlier phase and ultrasonic examination reveals floating intestines inside the abdomen. We did not face such complication in our experience.

Extraperitoneal leakage:

It mostly happens if the Foley catheter gets occluded due to a clot or debris. Urine seepage occurs from the bladder into extraperitoneal space. A thin puncture needle is inserted in the iliac fossa bilaterally under ultrasonic guidance and fluid is sucked out. Foley catheter is changed and urinary bladder is washed.

We had one such case, which was managed successfully by draining the extraperitoneal cavity and by changing the catheter and retaining it for three more days.

Fistula formation:

Insufficiency of the urinary drainage through the catheter may result in suprapubic fistula formation. Foley catheter should be irrigated in such case. Fistula closes in due time by itself.

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WHAT TO DO AFTER URINARY TRACT STONE REMOVAL?

Key points

Ample fluid intake (oral or parenteral) is necessary whether the stone is taken out percutaneously or through natural route. In all the cases antibiotics are given along with diuretics. Generally the patient is made to get up the next day of the operation. Those who have a retrograde ureteric catheter and it is left in for longer period, are allowed to walk around at their ease. Frequent availability of stents has reduced the need of ureteric catheter.

Results of operation are made certain by plain X-ray and if necessary, with Urography. If residual stone is not seen, tube (ureteric catheter, nephrostomy drain) is taken out. If there is no complication, the patient is discharged. Follow up is maintained.

According to international statistics 70% of small renal and ureteric stones can pass out spontaneously. Those statistics should not be altered with available facilities of ureteroscopy or nephroscopy. Indications should be strict. The main line of action should be, "if I have a urinary tract stone I shall wait for its spontaneous discharge or be operated by modern techniques".

This should be the guideline before every surgical intervention.

COMPLICATION OF ENDOSCOPIC RENAL STONE SURGERY

16

There is no surgical intervention that does not have complications. The same is true about endoscopic renal stone surgery. Even the endoscopic renal stone extraction seems to be an indulgent operation, it may have serious complication.

We have a series of more than 20,000 endoscopically operated cases at our two centres and met almost all variety of complications mentioned in literature[1, 2]. Those may appear during operation and postoperatively.

COMPLICATIONS

Infection:

Kidney is mostly infected during obstruction and temperature may appear[3]. Appropriate antibiotic coverage is necessary. Prior urine culture and sensitivity is much helpful. In severely infected cases urosepsis may also appear. That condition led to such situation in one patient that nephrectomy had to be done.

Febrility due to infection is observed more among staghorn, particularly in infection stone cases. This may be due to excessive manipulation. During that period patient can also suffer from anaemia due to blood loss during operation as well as due to infection. Transfusion may be required. Patient with infected urine seems to have a relation with haemorrhage[4].

Haemorrhage:

This can be extrarenal or renal[5]. In extrarenal a relatively frequently observed site is when the approach is intercostal in high lying kidney or upper calyx approach. In the first case we opened it and found there is no source of bleeding anywhere else than the intercostal vessels.

High intercostal entry should be made along the upper border of the lower rib as intercostal vessels run along lower border of ribs. If there is persistent bleeding, a deep suture above the point of entry when the needle almost touches both the ribs is sufficient to stop this bleeding by squeezing the intercostal area.

Bleeding may be encountered during operation and it can be massive to an extent that the field of vision is obscure. A drain is inserted and it is clamped. External pressure is applied to renal area if required. Procedure is paused for a few minutes. Drain is opened and checked. If bleeding stopped, another puncture and new passage is created.

Sometimes due to flow of normal saline bleeding cannot be noticed while at the end of operation there is bleeding through the drain. External end of drain is lifted up to check flow if it reduces. If it is continuous, the drain is clamped and external pressure is applied. If the patient is in prone position, an assistant holds from the opposite side of abdomen while a person from washed up team presses the operated side with one hand while the other hand is on the back medial to drain. Clamp is removed after a few minutes to check flow through drain. If blood mixed urine starts coming out, pressure is removed.

The same pressure manoeuvre can be applied by turning the patient supine and pressing the renal area. Pressure is increased gradually with expiration of the patient but it should not be so much that abdominal organs are damaged.

A Foley catheter can also be inserted to stop bleeding. 2 – 4 ml of contrast material is injected into the balloon. This balloon should not remain inflated for long time and it should be deflated gradually. Usually we start deflating it after half an hour.

Sometimes drain slipping causes excessive bleeding and this is particularly dangerous in solitary kidney. We met one such staghorn case. The stone was removed but the side of procedure grown tighter till next day when the abdomen on that side became stony hard with severe discomfort and pain. On exploration retroperitoneum was full of clots but the kidney was healthy. Among obese patients drain slipping seems to be regular phenomenon. If the kidney is dilated we leave a Foley catheter inside otherwise a drain is maximally inserted e.g., if the entry is through lower calyx it is pushed to upper calyx.

History of bleeding disorder is very important. Bleeding, clotting and prothrombin time is important before operation. If the patient has bleeding disorder, situation may lead to serious consequences.

Reason for exploration due to excessive bleeding came out to be interlobar vascular injury[6] in one case and injury to a branch of renal artery due to abrupt movement of the patient on the table causing medial rupture of pelvis in another case.

Secondary (delayed) haemorrhage may also occur. Patients are generally treated by stent placement, diuresis and blood transfusion if required. This can be due to transient ureteric occlusion and rise in intrarenal pressure and raw wound may cause bleeding. We had a case who developed severe haemorrhage two weeks after the percutaneous procedure. Exploration revealed a bleeding vessel that was tied. There was another eight years old boy in which persistent secondary haemorrhage could not be controlled and was led to nephrectomy.

It has been noted that there is a relation between longer duration of operation, infected urine and haemorrhage requiring transfusion[4].

Renal pelvic perforation:

It can be caused by excessive pushing of any instrument during dilation, ultrasound probe or stone grasping forceps when a part of pelvis is also grabbed along with stone. It is also noted that after longstanding obstruction and infection, tissue becomes fragile. Pelvic wall can easily be injured in such cases.

First two perforated cases were opened by us and pelvis was sutured. They healed without complication. Exploration was not done later on. It was noted that perforated opening healed within 1-2 days spontaneously in the presence of nephrostomy drain. It was confirmed by pyelography before removing the nephrostomy drain.

Sometimes hard broken stone fragments injure opposite pelvic wall and fall out during manipulation. That mostly happens when the wall is fragile and stone is pressed hard on the opposite wall. The fragments which can be taken out are picked with alligator forceps, not the triradiate forceps as it can cause unwanted injury while grasping the stone. Small unreachable pieces are left behind. Practical experience shows those do not cause any future disturbance. A stent is left inside along with the drain.

Blood clots:

A clot during operation can restrict nephroscopic view. In the early stages of our work, it happened three times. Flow of irrigation fluid was insufficient and the cavity did not fill up adequately. Field of vision was restricted because oozing blood was not washed out properly. Narrow field of vision was cleared by raising the irrigating fluid container and by using wider bore inflow tube. In that way clot formation and reduced flow factor could be eliminated. The patients did not suffer from any damage in all the three cases because the stones were removed through already prepared channel in a later session.

A clot can also obstruct ureteric passage and that will be discussed in ureteric occlusion.

Persistent renal fistula:

Generally fistula healing takes place within 48 hours. It may take longer time. Reasons may be obstruction to normal urinary downwards flow, thin parenchyma or lean persons. It is also noticed that lower calyx healing takes relatively more time than the upper calyces. A stent and a Foley catheter is inserted. Diuresis may also be applied.

Ureter occlusion:

It can occur when a stone fragment or blood clot obstructs natural urinary pathway[7]. Though a ureteric catheter is already present in the ureter during procedure, after large stone crushing a fragment may flow down the ureter unnoticed. It relatively frequently happens in cases having radiolucent stone. Renal wound clots after dissociation pass down and may hinder flow of urine. Though that problem can be overcome by inserting a stent but we experienced even the stent clogging with blood clots. Remedy to occlusion is inserting a stent, stent removal and its replacement or ureteroscopy accordingly. We did not meet with complete ureteric atresia mentioned by Kalalsh & Young[5].

Thoracic involvement:

There is chance of thoracic involvement in high intercostal approach during percutaneous surgery[8]. There may be pneumo, hydro, uro or even haemothorax. Patient complains of shoulder pain or respiratory distress and chest pain on the side of operation. A standing X-ray chest reveals the pathology. Fluid drainage or chest tube insertion may be necessary.

Pneumothorax or hydrothorax develops during operation while urothorax and haemothorax may develop postoperatively after removal of nephrostomy drain.

A stent may be required to prevent fluid leakage from renal entry point. Foley catheter is also retained along with the stent till the patient recovers. The stent and catheter ensures free orthograde outflow.

Free air can be seen in pneumothorax and fluid level is observed in hydrothorax in fresh X-ray chest film. We encourage the patient to inflate balloon. This helps lung to expand and early recovery. Diuretics help in absorption of small volume fluid in pleura.

At many occasions, thoracic involvement can be judged while dilating nephrostomy channel. Air comes out of wound at inhalation. If such thing is observed, puncture at that place is aborted and a new puncture site is selected. Occasionally it becomes necessary to enter that point only due to position of kidney or stone then the patient is monitored vigilantly during postoperative period. An extreme case hydrothorax X-ray pictures are given in Fig. 95.

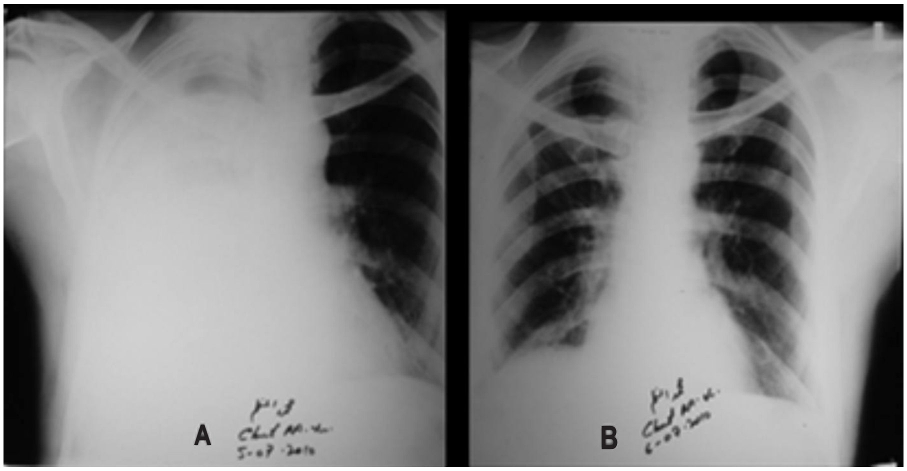

Fig. 95 A. Hydrothorax R side. Lung is almost invisible.
B. Chest tube was passed and fluid drained. Next day picture shows lung expansion.

Retrorectal abscess:

Large amount of fluid may accumulate in the retroperitoneum. This may happen during prolonged operation and seepage of fluid through loose connective tissue of the retroperitoneal space. It may accumulate in the dependent portion of the body. Though this fluid is isotonic and it can be absorbed and washed out with diuresis, it can cause abscess if it is infected. Proper antibiotic coverage helps infection prevention but we had one such case in which we had to drain pus from retrorectal space. Abdomen of that patient distended and she developed diarrhea on the 7th day of operation. On digital rectal examination dorsal wall of rectum was found protruding forward, became thickened and was palpable like dough. On puncturing with needle, pus came out. It was incised and drain was placed in. Within three days all the complaints disappeared, patient recovered and was discharged.

Abdominal organs injury:

If the entry is relatively anterolateral, there is more chance of peritoneal involvement. Large bowel can also be injured specifically in case of retrorenal colon[9]. Its chance increases when congenital anomalies are also existing e.g., malrotated or horse-shoe kidneys. Approach should be relatively posteromedial in all cases but in malrotation it should be particularly considered. It is better if CT scan is done before the procedure in doubtful cases[10] but this facility is still not available at most of the places in developing countries.

We had to perform explorative laparotomy in one case of uroperitoneum and one case of peritoneal pus collection and peritonitis. In both cases gut injury was not observed. In the second case infected urine might have become the source of pus formation.

Large bowel injury, if detected during percutaneous operation can be managed conservatively by inserting drain near colon puncture site, a DJ stent in the kidney and a Foley catheter. We had one such case in which nephroscope entered large intestine instead of kidney. A drain was left at the colon injury site. Another site was selected for kidney puncture. The stone was removed, a stent was inserted and a nephrostomy drain was also inserted. Patient was retained in the hospital for six days under observation. Colonic drain was removed gradually. He was discharged after complete healing.

Colonic injury[11] may cause severe peritonitis if the puncture needle involves colon, free surface is also pierced through and channel is dilated through this route. Delayed intestinal injury detection may bring untoward consequences.

Flank bulge:

This is a rare complication in which a bulge appears on the side of abdomen while the patient is in standing position[12]. In first look it appears to be hernia-like protrusion. It seems to extend from the rib and is in its line towards abdomen. This is due to intercostal nerve injury during intercostal approach and resolves itself in few weeks.

Hypersensitivity to contrast material:

Even if patient hypersensitivity is unknown its chance is lesser than IV contrast injection because contrast material is instilled in the renal cavity. Even then, there may be retrograde ascend or extrarenal contrast spillage during procedure. Otherwise contrast allergy is already known because the patient had already gone through IVU examination. If it happens, it causes skin allergic reaction, sudden hypotension and unconsciousness during operation.

Key points

- Too much inward pushing of drain may cause irritation resulting nausea, vomiting and transient paralytic ileus. Confirm its location on next day postoperative X-ray picture.
- High approach may cause diaphragm irritation causing hiccough that sometimes prolongs. This may also occur due to air or fluid collection under the diaphragm. It vanishes with passage of time.

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FOLLOW UP OF PATIENTS WITH RENAL STONES

17

Renal stone has the first place in the urological disease list and is the most common diagnosis in urology. That is particularly true about the areas with hot climate around the globe.

After stone removal follow up of the patients is necessary due to risk of recurrence. During follow up period utmost effort is made to restrict stone reformation.

Without necessary care, 30-75% of renal stones recur and against all the conservative measures, 1/3 of the stones have to be removed. In 1993 Saad el al[1] reported one year recurrence rate as 17%. Open surgery is still being performed on patients with renal, ureter, or bladder stones in developing countries, although 90-95% patients can be operated endoscopically.

Most important work to do against this prevalent disease is aimed recurrence prophylaxis (metaphylaxis) [2] because, without it, every second patients may have recurrent attack of stone formation. If care of such patients is taken and systematically they are given advice, ratio may decrease to 10-20%.

Follow up is a long term program and effective only when doctor and the patient has real cooperation. Follow up program according to Frang is: recovery, prevention, advice, information, education, direction and checkup.

Since 1974 modern conservative management of stones i.e., driving off the stone, stone dissolution and its surgical solution (instrument removal, open operation, plastic-repair operation), their analysis and on the basis of it aimed prophylaxis is performed at our department in Hungary. Since 1984 we expanded our program to the patients who were operated through percutaneous nephrolithotomy and transurethral ureterolithotripsy. In 1992 another department of stone surgery was established in Pakistan which has been taking active part at therapeutic as well as research level.

Stone is “only” a symptom, a form of presentation of some generalized humoral disturbance affecting the urinary system or due to anatomic change in the urinary tract e.g., a stricture in the urinary tract or disturbance of flow of urine. So if only stone, “the symptom” is removed and care of patient is not taken afterwards, recurrence of stone may take place.

Four major points were used in the organization of our follow up work.

1. Active research
2. Record maintenance
3. Active observation
4. Medical therapy, prevention, rehabilitation.

Completely valuable follow up can only be taken into account if all the fours have been attained.

Stones removed from the kidney should be analyzed in all cases. Previously we used Berenyi's microchemical system - Harzalith (Reanal) in Hungary and Merckognost kit in Pakistan for chemical analysis. Though more advanced and accurate systems of stone analysis exist now, chemical analysis should be the minimum to be available even at 'low economy' areas of the world.

Analysis starts by observing the stone on the X-ray picture or when its surface is seen endoscopically. On the basis of chemical composition of stone, preventive measures for that particular stone are adapted before taking general steps.

GENERAL RULES

1. Plenty of fluid intake, systematically and frequently. Quantity of fluid should be so much that daily urine formation is 1.5-2 liters, with specific gravity below 1.017. Half a liter fluid should be taken before sleep so that urine does not get concentrated. As the quantity of urine production varies in different climates it is advised in general that fluid intake should be so much that the colour of urine is white.
2. Abundant body movement: Gymnastic, swimming, exercise, walk and if possible, patient should stand upside down at least once a day for few minutes. Kidney is also turned upside down in this way.
3. Drying up of system is avoided. Excessive perspiration and long sun baths are not allowed. Those who work in warm climate should take a lot of fluid.
4. Cold is avoided. Region of kidneys, region of urinary bladder and legs should be avoided to get chilled.
5. Don't gain weight.
6. Focuses of sepsis should be treated, teeth, tonsils, gynecological and urological focuses are the important ones.
7. GIT system. Inactive preventive management of stones and regulation of eating habits still has no united standpoint. In the follow up period for the first year, everyday medicine intake, diet and urine concentration under 1.017 is tried to be maintained. Routine checkup is performed after two weeks at start and then after every third months (sediments in the urine, bacterial culture). In the 2nd year three monthly, in the 3rd year six monthly and from 4th year once yearly the patient is asked for follow up examination. During these years medicinal intake and diet is loosened gradually. After 4-5 years of therapy, diet program is finished but plenty of water is still needed to be taken.

Calcium oxalate mono or dihydrate stone alone or in combination with different other minerals is the commonest variety of stones which forms 70-90% of the total in European statistics while Pakistani population has approximately 50% stones having calcium oxalate in combination with uric acid.

STONE SPECIFIC PRECAUTIONS[3]

Calcium oxalate stones:

A combination of atropine sulphate, diazepam, magnesium citrate and potassium citrate along with vitamin B6 (pyridoxine) is used for calcium oxalate stones where the facility of dispensing is available at the clinic. Otherwise patented powder or tablets are freely available in the markets of even the developing countries.

Serum parathyroid level should be checked. Sometimes osteoporotic changes are seen during viewing the KUB plain film for stone. This may be due to hormonal imbalance.

Generally milk intake should not be restricted. Its restriction may lead to free availability of oxalate in the intestine to be absorbed. On the other hand excessive calcium is also not good. Natural calcium intake increase is helpful. Coffee, cocoa, and chocolate should be avoided as these are the source of oxalate.

It is observed that patient with oxalate stones perspire more and are more anxious as compared to other stone patients.

Atropine reduces the spasm of smooth muscles of urogenital system. Salivary and sweat gland functions diminish due to its effect. In such a way amount of fluid and salts which evaporates through sweat go out through kidney. As a result, quantity of urine increases, its concentration decreases and crystal formation and adherence is lesser in diluted urine.

Diminution in the functions of salivary glands may cause dryness of mouth and throat. This effect urges the patient to drink more and necessary amount of fluid is taken in (1.5-2.5 liters daily).

Diazepam (or other sedatives) helps decreasing anxiety, irritability and vegetative neurotic complaints in oxalate stone patients.

Urine calcium level decrease with thiazide diuretics is known since long. Contrary to other diuretics, thiazide forms a complex of unabsorbed calcium in the intestine with oxalate which is insoluble and in this way also prevents the absorption of oxalate. Hypothiazide decreases calcium excretion in the urine and increases excretion of magnesium inhibiting its crystallization in urine. It increases diuresis and decreases urine concentration. Potassium loss which is caused by 50-100 mg of hypothiazide per day can be compensated by giving 3-5 grams of potassium citrate.

Magnesium intake is necessary because it inhibits calcium oxalate crystallization in urine. In the presence of magnesium ions, dissolution of calcium oxalate takes place and magnesium oxalate is formed which dissolves in the urine and in this way it inhibits the tendency towards crystallization. Magnesium insufficiency occurs by excessive intake of proteins, excessive calcium intake, alcohol abuse and too much perspiration. Due to the effect of magnesium, fibrinolysis increases and in this way there is less possibility of stone formation on the blood clots and fibrin clots (heterogeneous nucleation). So magnesium helps in elimination of focus (fibrin) of crystallization. It also inhibits focus formation by delaying calcium phosphate crystallization.

Magnesium and pyridoxine together decrease the formation of oxalic acid from glycooxalic acid. Pyridoxine has also a role in decreasing endogenous oxalate formation. Magnesium and pyridoxine have an effect to inhibit uric acid and calcium oxalate mixed stones. Pyridoxine also helps increasing magnesium contents of blood plasma and tissues (intracellular).

Potassium is given because in its presence, ingredients which play role in stone formation get dissolved, so its effect is against crystal formation. 18% of patients with stone are hypokaleuric while serum level remains within normal limits. Potassium voidance increases by oral potassium intake and affects prophylactically. Potassium depletion due to the effect of hypothiazide is compensated by oral potassium doses. Because tubule potassium reabsorption is not very much so, it remains in the urine and in this way inhibits its condensation.

With increased secretion of citrate and alkalization of urine, calcium oxalate dissolution increases. Citrate makes stable complex with calcium which inhibits calcium oxalate formation. In about 1/3rd of calcium oxalate stone patients hyperuricosuria can be observed. Calcium oxalate stone formation increases when uric acid content is high in the urine. That is prevented by citrate intake. Sodium and meat content in food should be reduced. Increased purine in blood may lead to low citrate level. High serum uric acid level in calcium oxalate patients can be decreased with allopurinol (Milurit, Zyloric).

Weddellite stones due to risk of recurrence need more intensive follow up as compared to whewellite stones.

Uric acid stones:

Patients with uric acid stone (10-20%) take allopurinol granules, dose of which depends upon pH value. As uric acid level in the serum shoots above the normal limits, allopurinol is started.

Alkalization is important in dissolving the uric acid stone. If pH of urine is maintained around 6.5, stone dissolves within certain period (in months). In Hungary, Frang and co-workers wrote article about first uric acid stone dissolution in 1967. 90% of plain uric acid stones can be dissolved but contrarily sometimes it is necessary to remove these stones percutaneously. It is not worthwhile to try dissolving mixed multiphasic stones for example uric acid + calcium oxalate monohydrate or uric acid + struvite and carbonate apatite stones. Percutaneous removal is suggested for these stones which can be helped with local application of alkalizing solution. Allopurinol is used to prevent recurrence. Optimal intake of medicines is necessary in the follow up period.

Food contents should have less purine and urine acidifying agents (liver, kidney, brain, meat, eggs and bread) and foods which cause alkalization of urine (vegetable, potato, salads, fruit and lemon) should be consumed more.

Struvite & carbonate apatitie stones:

Gram-negative bacteria (Proteus, Pseudomonas aeruginosa) having urease enzyme are responsible for struvite and carbonate apatite stones. Proteus group which causes urinary tract infections decompose urea, with that it causes hyperammoneuria and alkalization of urine takes place. In such urine the stones increase in size rapidly (within weeks or months) in the renal cavity or ureter. Recurrence rate is high after their removal.

Ideally, the first step as prevention after percutaneous stone removal, especially after the ultrasound stone disintegration, is to irrigate the cavity with acidic solution and this is performed through days. This is also adapted for the reason that small stone particles wash out from the cavity.

After clearing the cavity of stone, one step is urine acidification with ammonium chloride, solvent mixture, ascorbic acid, methionine or nut oil so far as it is not contraindicated (e.g. in renal tubular acidosis). It is better that urine pH is around 5-5.5 for a long time. Dissolution of phosphates increases in acidic medium. In the immediate postoperative period renal cavity may be irrigated with low pH solution[4] to dissolve small fragments. Those can become nidus for stone recurrence.

It is important to use exact antibiotic for a long period. This is performed on the basis of bacterial culture by giving antimicrobial medicine for months.

Urease effect can be decreased by acetohydroxy acid but its clinical use still did not get civil rights. Phosphate enteral absorption is inhibited by aluminum hydroxide or almagel. Its mechanism is that aluminum phosphate is formed in the GIT which is unabsorbable. With this urine phosphate level becomes low. Alkaline fluids and lemon intake is avoided.

Cystine stones[5]:

Recurrence rate of these stones is the highest needing vigilance in metaphylaxis.

Urine is alkalized to pH 7.5 – 8.0. Citrate mixture (Magurlit) or sodabicarb is used for this purpose.

Overloading with sodium should be kept in mind.

It is necessary to increase the quantity of urine to 2-3 liters. The patient should take 600 ml fluid every four hourly (during night too). In this way 2 ml of urine forms each minute which helps preventing stone formation.

Quantity of cystine to be excreted every day should be decreased. This can be achieved with D-penicillamine or alpha-mercaptopropionyl glycine (Thiola). These agents form mixed disulphides with cystine which dissolve easily.

Protein intake should be decreased. It is advisable for patient to take herb proteins poor in cystine and methionine. Large quantities of alkalizing fluids should be taken.

Our follow up of patients since 1974 and other researchers' results show that with implementation of metaphylaxis stone recurrence is really low. Stones formed even after preventive measures can be removed through endourological or extracorporeal lithotripsy techniques. In such a way it is successful to change the medicinal therapy of renal stones fundamentally and make the disease bearable.

It is better to prevent stone formation instead of taking it out by any new method.

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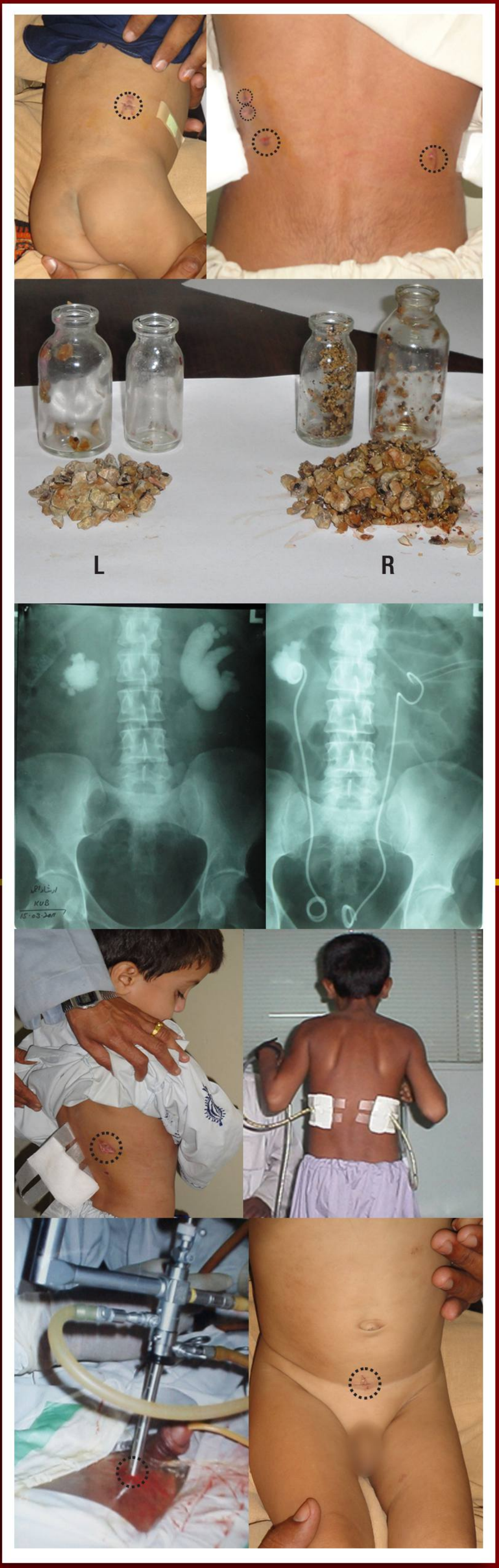

Manual of
ENDOSCOPIC URINARY TRACT STONE SURGERY

This is the practical guidebook to perform endoscopic urinary tract surgery, written in the perspective of learning basic techniques particularly for the urologists working in developing countries where the availability of equipment is restricted. Hopefully, it will be equally beneficial for the beginners at technically advanced centres. If someone learns fundamental procedures, it is easy to use next generation and higher level equipment.

Along with urologist, house surgeons can equally benefit from this manual. General physicians as well as interested readers will also find it useful.

Simple language is used to narrate different procedures made understandable with the help of X-rays, illustrations and schematic diagrams. Main emphasis is on urinary tract stone surgery.

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